EVALUATION OF BYPRODUCT COMBINATIONS ON FEEDLOT PERFORMANCE, CARCASS, AND FECAL CHARACTERISTICS

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CHAPTER I

INTRODUCTION

Products of dry and wet milling have produced food, ethanol fuel, beverages, and oils for human consumption over the past century. A growing need for more fuel and food has increased use of these methodologies of grain processing. In 2011, the ethanol industries used 5 billion bushels of corn, from 12.36 billion bushels harvested, to produce 13.9 billion gallons of (40% of the corn supply) ethanol (RFA, 2012). From this production, 35.7 million metric tons of distillers grains, 2.9 million tons of corn gluten feed, 0.6 million tons of corn gluten meal, and 1.5 billion pounds of corn oil (RFA, 2012) were also produced as byproducts. The growing demand of ethanol and food based products of corn have increased the demand and the cost of the grains. High grain cost has caused cattle feeders to switch ideology of feeding high concentrations of cereal grain based diets to incorporating byproducts from wet and dry-milling to lower ration cost at levels to support cost efficiency. Historically, the cattle feeding industry was built upon feeding "cheap" corn. Cheap corn prices migrated cattle production from predominantly corn-belt areas (Iowa, Nebraska, Illinois, etc.) in the 1960s to more southern areas (Texas, Oklahoma, Kansas) beginning in the early 1970s (Klopfenstein et al., 2008).

The advent of ethanol production, energy demands, and global increase in food need has caused a greater demand for corn. Prices have shifted greatly from under $3.00 per bushel from the early 2000’s to over $7.00 per bushel in 2011.

Byproducts offer opportunities to decrease ration costs and increase performance in DRC-based diets and HMC based diets (Corrigan et al., 2009; Ham et al., 1994; Klopfenstein et al., 2008; Larson et al., 1993; Lodge et al., 1997; Loza et al., 2010; Stock et al., 2000; Vander Pol et al., 2008). However, incorporating higher amounts (> 50% of DM of diet) of byproducts in finishing rations can decrease performance and have negative side effects due to high concentrations of sulfur (polioencephalomalacia or “brainers”) (Gould, 1998; Klopfenstein et al., 2008; Neville et al., 2012).

Over the past twenty years, research has evaluated and better understood the value of feeding byproducts in ruminant diets. Furthermore, the wet and dry grain milling facilities have also better understood the value in methods of producing more consistent grain byproducts. This has allowed for potentially greater levels of incorporation of these byproducts in finishing diets. Blending byproducts from the wet and dry milling industries may have beneficial effects (Loza et al., 2010). Choice of byproduct(s) can be limited to cost, transportation, storage, usage, and supply. Increasing incorporation of byproducts in feedlot diets causes environmental concerns with nitrogen and phosphorus levels in manure. Additionally, high levels of byproduct diets have not received much attention on pen condition, which could have sub sequential effects on animal welfare and performance.

The objectives of the experiments presented herein include: 1) Evaluate the effects of blending WCGF:DDGS on a 1:1 blend on feedlot performance, fecal, and carcass characteristics to compare high levels of blended byproducts to a conventional feedlot diet; and 2) Evaluate the effects of titrating wet sorghum-based distillers grains plus solubles to dried corn distillers grains on feedlot performance and carcass characteristics.

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CHAPTER II

REVIEW OF LITERATURE

BYPROCUTS IN FINISHING FEEDLOT DIETS

DRY MILLING

Dry milling plants ferment grain, mainly corn, to produce ethanol (Stock et al., 2000). Since early 2000s ethanol industry has grown substantially from producing 2.1 billion gallons in 2002 to producing an estimated 13.9 billion gallons in 2011 (RFA, 2012). This expansion is due to US energy/oil demand where ethanol can be blended with gasoline for fuel, cutting down the need for crude oil. Ethanol is the product from a process distilling fermenting starch sources. Production of ethanol comes from the fermentation of starch by microbes to ethanol, whereas cereal grains have long been a source of starch for fermentation. Choice of cereal grains varies from region to region, with the most common cereal grain used being corn (maize) (Klopfenstein et al., 2008). Common cereal grains include: corn, sorghum, wheat, milo, and barley. Corn has been a popular cereal grain for fermentation due to its availability and cost. Corn is approximately two-thirds starch.

Removing the starch allows for the resulting product to be more concentrated in the nutrients, protein increases from approximately 9% to 27%, fat from 4% to 12%, neutral detergent fiber (NDF) from 10% to 30%, and phosphorous from 0.3% to 0.9% of dry matter (Klopfenstein et al., 2008). Distillers grains were first noted for their protein content and incorporated as a protein supplement in feedlot diets (Klopfenstein et al., 2008). NRC (2000) stated that DGS are comprised of approximately 30% CP, 46% NDF, 21.3% ADF, and 90% TDN on a DM basis. From ethanol production, 1 bushel of corn can yield 2.8 gallons of ethanol, 17.5 lbs. of feed-able byproduct, and 17 lbs. of carbon dioxide (RFA, 2012). Ethanol is the product of fermented starch component of cereal grains, mainly corn (Ham et al., 1994; Klopfenstein et al., 2008; Larson et al., 1993), which the byproducts are more concentrated then the original cereal grain. Distillers grains were included in finishing rations was first incorporated as a protein source being that DGS have a CP from 27 to 32% (Klopfenstein et al., 2008). The protein content depends on the amount of distillers solubles (DS) added back to the distillers grains after centrifugation. The yeast content in the DS is a valuable component to ruminally undegradable protein RUP because heat denatures yeast, which makes them resistant to microbial degradation (Bruning and Yokoyama, 1988). The protein content of distillers' grains was the original attribute of inclusion in feedlot diets prior to inclusion rates above 20% DM, then it becomes an energy source.

Wet milling

Wet-milling was noted by Stock et al. (2000) as a complex process, which involved the methods of separating the starch from the kernel. Blanchard (1992) stated that wet milling produces a high purity corn starch slurry suitable for syrup production or for manufacturing of high quality dry start. The primary concern of the wet milling industry is to remove starch from the kernel and purify it for food grade products such as corn syrups. Corn is screened for crop residue removal, fines, broken kernels and is steeped in a dilute sulfurous dioxide solution for approximately 40 to 48 h. The sulfur dioxide is used to clean any soluble impurities from the kernels as well as initiate proteolysis of the protein matrix in the kernel. The kernels are then ground and centrifuged to differentia kernel separation. The starch is isolated and can be sold dried or further processed into other products such as high fructose corn syrup or other corn syrup products. However, starch is not the only component that can be separated during the wet-milling process; corn germ is another valued portion of the kernel. From the kernel, germ oil can be extracted and used as food grade corn oil. After the oil is extracted from the corn germ, the remaining byproduct is then referred to corn germ meal. Corn germ meal is normally incorporated into corn gluten feed or can be sold separately. Corn germ meal is dried down to approximately 90% DM and has a CP of 25%. The primary byproduct, in terms of volume, form corn wet milling is corn gluten feed (CGF) (Blanchard, 1992). The majority of CGF is comprised of a mix of steep liquor and corn bran. The two can be proportioned at the processing facilities own discretion. Stock et al. (2000) reported CGF having 93 to 100% of the feeding value of corn. NRC (2000) stated that CGF is comprised of approximately 23.8% CP, 36.2% NDF, 12.7% ADF, and 80% TDN on a DM basis. The majority of CGF (70 to 75%) is exported to Europe (Stock et al., 2000). Additionally, another byproduct of wet-milling is corn gluten meal. Corn gluten meal is high in crude protein and RUP, and is primarily used in pet and poultry food industries (Stock et al., 2000).

Evaluation of byproducts

Byproducts from both dry and wet-milling plants offer lower cost options when substituting portions of corn or other high starch component in ruminant diets. Both have their advantages of containing higher contents of protein, fat, and digestible fiber portions compared to corn. Erickson et al. (2010) examined a meta-analysis of byproducts nutrient content (Table 1-2). This shows that plant operations contribute a great variation in byproduct nutrient analysis. Byproducts are typically 80-90% the relevant cost of corn, making an attractive substitution for portions of corn in feedlot diets. From 2011, 39.4 million metric tons of livestock feeds came from ethanol producers (RFA, 2012). The abundant supply of distillers grains have been able to replace portions of corn in feedlot diets and impact animal performance compared to diets containing corn as primary energy source. Currently, ethanol plants produce more distillers' grains then current local demand can utilize. This drove DGS to be dried for transportation to regions further away from ethanol plants.

On the other hand, the wet milling industry is a smaller industry compared to dry milling, and produce a different byproduct available for producers to utilize. Byproducts have increased in production in the last 20 years and the corn milling industries are going to keep competing with current corn prices for production. Corn prices have reflected this in the past four years with corn ranging from $4.00/bu to $8.00/bu. Byproducts offer capability of lowering feeding costs and increasing feedlot animal performance (Erickson et al., 2010; Klopfenstein et al., 2008). Variability from plant to plant is still one of the greatest concerns for incorporating byproducts in cattle diets. Weekly compositions of

WDGS from Ham et al. (1994) ranged from 26.5 to 37.6% DM averaging 32.0%. This makes determining of total DMI difficult to calculate due to changing DM content.

Sulfur Toxicity/ Sulfur induced Polioencephalomalacia (PEM)

Corn contains approximately 0.14% to 0.16% sulfur and with the removal of the starch component this could suggest that the DGS would have approximately 0.45% sulfur (Klopfenstein et al., 2008).A major concern with inclusion of byproducts in feedlot diets is the sulfur content of the byproduct due to processing techniques from the dry and wet milling industry whereas, high concentrations of sulfur in the rumen can lead to a sulfur toxicity better known as Polioencephalomalacia PEM. Polioencephalmalacia is a neurological disorder of ruminants characterized by necrosis of cerebral cortex (Gould, 1998). Clinical signs include blindness, ataxia, and sometimes recumbency with seizures (Gould, 1998). During the processing phase for dry and wet milling production, sulfur is added in the form of sulfuric acid and sulfur dioxide to help clean impurities from kernels, controlling pH, and cleaning of distillation columns (Klopfenstein et al., 2008). NRC (2000) suggest that the upper limit of sulfur in the diet is 0.4% of DM meaning above this level would be toxic. Sulfur in the rumen is reduced to H2S by sulfur reducing microbes. Water is also a source of sulfur, thus to predict total sulfur intake one must analyze water as well as feed for total dietary sulfur. Principle route of absorption is thought be to by inhalation by eructation. Gould (1998) noted that other factors such as acidic ruminal conditions could favor increased rumen gas cap concentration of H2S. In addition to byproducts containing higher sulfur content, they are also low in pH, which could further enhance the onset of PEM. Klopfenstein et al. (2008) noted that diets above

0.58% sulfur increased diagnosed cattle from 0.38% to 6.06% PEM. Overall, increasing byproducts will increase dietary sulfur, which will increase the likelihood of PEM.

Processing corn for feedlot diets

Cereal grains are typically used for cattle being fed high energy diets. Cereal grains have high starch load which is then fermented into VFA’s for animal utilization for energy conversion. Cereal grains can be further processed to increase overall digestibility (NRC, 2000) of nutrients, particularly the starch component of the cereal grain. Processing grains disrupts the physical structure of the grain and can denature chemical bonds of nutrients, allowing easier access of microbes to the nutrients of the cereal grain. Methods of processing include: dry processing include: whole grain, grinding, dry-rolling or cracking, popping, extruding, extruding, micronizing, roasting, pelleting, thermalizing, wet processing include: soaking, steam rolling, steam processing and flaking, reconstitution, exploding, pressure cooking, early harvesting, ear corn silage, sorghum head silage (Hale, 1973).

Steam-flaking corn (SFC) uses high temperature moisture to soften the kernel then rollers to press the grain to a desired density. This has allowed for better utilization of the cereal grain and hence greater conversions. The density of SFC can be controlled by percent moisture and size of kernel post rolling. Flaking corn reduces the ratio of acetate to propionate production in the rumen (Hale, 1973). Steamed flaked corn reduced DMI 9% ($P<.10$) and increased feed efficiency 14% ($P<.01$) (Barajas and Zinn, 1998). Diets containing SFC have a 13.4 and 14.2 percent more NEg and NEm respectively than dry-rolled corn (NRC, 2000). Comparing SFC to dry-rolled corn (DRC), SFC had a lesser ruminal pH at 0h and was greater pH at 6h post feeding (May et al., 2009). Steam flaking corn results in a higher gas production (Hale, 1973). Vasconcelos and Galyean (2007) stated that 19(65.52%) feedlot nutritionist utilized SFC as primary source of grain processing method. This does not necessarily mean that 66% of the feedlot industry uses SFC as primary grain processing method, just that the majority of feedlot nutritionist prefer SFC to other methods. Following SFC for primary method of grain process in Vasconcelos and Galyean (2007) survey is dry-rolling corn (DRC). This process utilizes rollers to press or grind down the grain kernel making it easier to digest by microbes. The use of DRC is more common in the corn-belt region due to the ample supply of corn and lower cost of transport. Overall, SFC offers better efficiency but has a poor response to DGS inclusion, which will be discussed later.

Ruminal Acidosis

High concentrate diets, rich in fermentable carbohydrates, are digested in the rumen by microbes to produce VFA and lactate. These conditions supply the basis for what is known as acidosis in the ruminant species (Owens et al., 1998). High grain diets in beef cattle can produce ranges in pH from 6.5 to 5.6, with an average pH around 5.8 to 6.2 (Nagaraja and Titgemeyer, 2007). Thus a pH of 5.6 or below is generally considered being acidotic with pH between 5.0 and 5.6 being classified as subacute acidosis, and a pH of less than 5.0 being classified as acute acdosis (Nagaraja and Titgemeyer, 2007). Ruminal pH has a profound effect on the microbial population in the rumen (Nagaraja and Lechtenberg, 2007). As ruminal pH declines acid resistant microbes thrive with less competition of other micro-organisms. During periods of low pH, Lactobacillus ruminis and Lactobacillus vitulinus thrive due to their tolerance of low pH and production of lactic acid (Nagaraja and Lechtenberg, 2007). Additionally, other microbial populations will decrease, which also decreases VFA production and concentration. Low pH can lyse gram negative bacteria, which can release endotoxins free in the rumen (Nagaraja and Lechtenberg, 2007). Factors that can affect acidosis include feed delivery, grain type (high moisture, DRC, SFC or sorghum) amount of grain in diet, type and amount of roughage and feed additivies (ionophores) (Nagaraja and Lechtenberg, 2007). Animal subjected to ruminal acidosis can develop rumenitis, laminitis, or liver abscesses, which can be reflective in decreased performance (Nagaraja and Lechtenberg, 2007). Preventative measures for acidosis rely mainly on the nutritional program of the animal. Proper adaption protocols are critical in establishing abundant and thriving ruminal micro-organisms. Byproducts have been regarded to help reduce the incidence of acidosis due to greater performance when included in finishing diets (Klopfenstein et al., 2008; Krehbiel et al., 1995; Lodge et al., 1997). Overall, ruminal acidosis is still a major metabolic problem in the feedlot industry, whereas, byproducts could play a role in mitigating incidences of acidosis.

Effects of DGS on animal performance in the feedlot

DGS in DRC diets

During the early 1990s the ethanol industry saw slow growth up into the early 2000s, where its greatest growth as an industry began. Larson et al. (1993) examined feeding wet distillers grains to determine a feed value compared DRC when included in the control diet at 79.0% DM basis. Wet distillers grains were fed at 5.2, 12.6, and 40% DM of the finishing diet of yearling steers and calves. WDGS replaced portions of soybean meal and urea in finishing diets in the lower inclusion rates and replaced all of the soybean meal and urea in the 40% WDGS inclusion diet. Yearlings responded linearly with increasing levels of WDGS. Increasing WDGS resulted in a linear and quadratic response in yearlings for efficiency. Fat thickness, liver scores, and quality grade were not affected by inclusion levels of WDGS. Calves examined by Larson et al. (1993) had similar performance compared to yearlings, consuming less DM, gaining weight faster which resulted in being more efficient compared to the control group. Estimated NEg increased from 1.34 Mcal/kg to 1.53 Mcal/kg for 0 to 40% WDGS inclusion (Larson et al., 1993). No interactions were noted for fat thickness and liver scores with WDGS inclusion. However, calves fed increasing levels of WDGS graded higher than control calves (Larson et al., 1993). Corrigan et al. (2009) evaluated steer performance of WDGS in dry-rolled corn based-diets. Wet distillers grains were included at 0, 15, 27.5, and 40% DM basis for treatment diets. Increasing WDGS resulted in a linear increase in ADG, G:F, HCW, and fat thickness. No interactions were noted for other carcass characteristics. Ham et al. (1994) observed similar finishing performance and carcass characteristics to Corrigan et al. (2009). Cattle had greater gains and more efficient cattle with cattle fed wet and dried distillers byproducts. No interactions between treatments were noted for liver scores, fat thickness, yield grade, and quality grade for cattle (Ham et al., 1994).

A study by Buckner et al. (2008) evaluated finishing diets containing 0, 10, 20, 30, and 40% DDGS on a DM basis. This study reported a quadratic effect on final BW and ADG as DDGS increased; with 20% DDGS being the greatest observed value for ADG. Furthermore, inclusion of DDGS resulted in a quadratic effect on HCW with no other differences seen in other carcass characteristics. Buckner et al. (2008) reported maximum ADG would be achieved at 23.5% DDGS inclusion from regression analysis. This is similar to a meta-analysis evaluated by Klopfenstein et al. (2008), indicated that maximal gain was achieved at 25.7% and maximal G:F achieved at 10-20% DDGS inclusion. Replacing DRC at any of the study amount resulted in numerically greater amounts compared to the control ration. These data contrasts findings of Erickson et al. (2010); Ham et al. (1994); Klopfenstein et al. (2008), which found greatest ADG and G:F achieved at inclusion levels of 30-40% WDGS on a DM basis in DRC-based diets, implying an interaction between wet and dry DGS. Klopfenstein et al. (2008) compared WDGS to DDGS at 20% DM inclusion and reported a difference in feeding values by 19 percentage units and 31 percentage units when comparing DGS at 40% dietary DM, from which there was no biological mode of action to explain the difference. Neville et al. (2012) evaluated DDGS inclusion in DRC diets at 20, 40, and 60% on DM basis. Performance results responded in a decreased quadratic effect on ADG and DMI with increasing concentrations of DDGS (Neville et al., 2012). Animal efficiency responded in a decrease linear effect with increasing DDGS concentration (Neville et al., 2012). Carcass data resulted in a decreased quadratic effect on carcass-adjusted ADG and a linear decrease in carcass-adjusted final BW and HCW with increasing concentrations of DDGS (Neville et al., 2012). Carcass back fat thickness also decreased linearly, which was attributed to a linear decrease in USDA yield grade (Neville et al., 2012). Carcass marbling score was not affected by DDGS inclusion in diet (Neville et al., 2012).

DGS in SFC diets

Steam-flaked corn is often used in feedlots to optimize animal performance and efficiency in finishing diets (Barajas and Zinn, 1998). A study by Depenbusch et al. (2008b) evaluated DGS in SFC-based diets in yearling heifers. Three treatment diets were utilized: a control diet utilizing no DGS, second diet containing 13% corn DDGS from traditional methods of distillation, and a 13% corn DDGS derived from a partial fractionation dry-grind process. Feedlot performance from DMI, ADG, and G:F resulted in no difference between control and DGS diets (Barajas and Zinn, 1998). Heifers in the traditional DDGS treatment consumed more feed than the fractionated DDGS group (Barajas and Zinn, 1998). Carcass data yield no difference in 12th rib back fat thickness, dressing percent, HCW, LM area, USDA yield grade or quality grade, marbling score, and liver scores (Barajas and Zinn, 1998). A second study by Depenbusch et al. (2008a) evaluated inclusion of WDGS in SFC-based diets along with feeding monensin and/or tylosin. Two dietary treatments were utilized on yearling heifers consisting of 0 or 25% inclusion of WDGS in SFC-based diets. Heifer performance favored SFC-based diets without WDGS (Depenbusch et al., 2008a). Steam flaked corn heifers gain faster and more efficiently compared to WDGS treatment diet (Depenbusch et al., 2008a). Heifers not fed WDGS had a greater dressing percentage and heavier carcasses compared to 25%WDGS diet (Depenbusch et al., 2008a). Furthermore, carcass marbling score and USDA quality grade of choice or better were greater for SFC diet compared to WDGS inclusion diet. Cattle fed WDGS had less fat and lower USDA yield grades compared to control cattle. Depenbusch et al. (2009) evaluated a comparative study utilizing SFC as the principle energy source to sorghum wet and dry DGS and corn wet and dry DGS. Dietary treatments include: control with no distillers grains, 15% wet-sorghum DGS with

0 or 6% alfalfa hay, 15% dry-sorghum DGS with 0 or 6% alfalfa hay, 15% wet-corn DGS, and 15% dry-corn DGS. Dry matter intake, ADG, G:F and carcass characteristics were similar for steers fed diets with or without 15% DGS (Depenbusch et al., 2009). Roughage level fed in sorghum DGS diet resulted in greater DMI, and final BW than steers fed 0% alfalfa; however, G:F were not different between roughage concentrations (Depenbusch et al., 2009). Furthermore, sorghum diets with alfalfa resulted in heavier carcasses, and higher USDA yield grades compared to steer fed 0% alfalfa (Depenbusch et al., 2009). In contrast Leibovich et al. (2009) noted a decrease in G:F in steers fed sorghum WDGS (SWDGS) in SFC diets. In addition, SWDGS steers had a decrease in HCW and dressing percent compared to 0% SWDGS (Leibovich et al., 2009). Furthermore, Luebbe et al. (2011) noted final BW, ADG, G:F, HCW 12th rib fat depth, and marbling score linearly decreased with increasing concentration of WDGS. Dry matter intake had a quadratic response to increasing concentrations of WDGS, with maximum DMI noted at 15 and 30% WDGS (Luebbe et al., 2011). May et al. (2010) compared feeding corn versus sorghum distillers grains in SFC-based diets. Treatment diets included 0% DGS, 15% sorghum distillers grains (SDG), 30% SDG, 15% corn distillers grains (CDG), 30% CDG, 15% of a 50:50 blend of CDG and SDG, and 30% of a 50:50 blend of CDG and SDG. Feedlot performance resulted in great final BW for control treatment cattle. The 15% WDG diet resulted in greater final BW and carcass adjusted final BW than cattle fed 30% WDG (May et al., 2010). Sorghum WDGS resulted in greater overall DMI versus then blended WDGS byproducts (May et al., 2010). Hot carcass weight was greater for cattle fed WDG versus control cattle.

Increasing from 15 to 30% WDG in diet resulted in a decrease in HCW (May et al., 2010).

Effects of WCGF on feedlot animal performance

WCGF in DRC diets

Wet corn gluten feed has been used extensively in the feedlot sector with properties that make it a valuable feedstuff. Ham et al. (1995) examined the feeding value of WCGF and dry corn gluten feed in calves and yearlings. Treatment rations include feeding WCGF at 49% and 65% with alfalfa hay and 61% WCGF with 37% corn stalks. Control rations included 44% DRC with 50% alfalfa and 5% molasses or 33% DRC, 33% alfalfa, and 33% corn silage. Calves fed WCGF at 49% to 65% with alfalfa had greater daily gains and were more efficient than calves feed control rations (Ham et al., 1995). Calves fed 61% WCGF and 37% cornstalks had the lowest gain but were more efficient than control treatment groups (Ham et al., 1995). In a finishing study by Ham et al. (1995), WCGF was fed up to 70% of DM to replace DRC. Inclusion rates of 35-70% had gains and efficiencies that were similar to the control diets. A quadratic response in DMI and daily gains were seen in inclusion rates of 20, 40, 60, 90 and 100% of DRC in diets (Ham et al., 1995). Hussein and Berger (1995) found similar performance when they examined performance and digestibility of feeding WCGF in a growing and finishing. Treatment diets included utilizing WCGF at 0, 25, 50 and 75% of DM replacing high moisture corn and corn silage. Heifers that were fed 25% WCGF had greater ADG and G:F vs. the control groups (Hussein and Berger, 1995). A second finishing study was examined by Hussein and Berger (1995) WCGF inclusion at 0, 25 50 and 75% of dietary

DM replacing high moisture corn. Increasing dietary level of WCGF resulted in a quadratic response in ADG and G:F (Hussein and Berger, 1995). Furthermore, increasing WCGF resulted in a linear decrease in marbling score, USDA Choice carcasses and liver abscesses (Hussein and Berger, 1995). Heifers that were in the treatment group of restricted DMI resulted in a decrease of 12th rib fat thickness due to inclusion of WCGF in diet (Hussein and Berger, 1995).

In a finishing study performed by Farran et al. (2006), performance was examined by inclusion of WCGF at varying levels of roughage. Wet corn gluten feed was fed at 0 or 35% DM of rations and alfalfa hay was included at 0, 3.75 or 7.5% DM of diet. Cattle fed WCGF resulted in a 4.4% improvement in efficiency and ADG compared to cattle that had no WCGF in diet (Farran et al., 2006). Decreasing alfalfa hay in WCGF diets resulted in an increase in efficiency (Farran et al., 2006). Including WCGF at 35% DM of finishing ration resulted in greater DMI, and showed a tendency for greater ADG and HCW compared to control rations containing 0% WCGF (Farran et al., 2006). Greater 12th rib fat thickness and larger longissmus muscle area were also seen when including 35% WCGF in finishing DRC diets (Farran et al., 2006). Additionally, Richards et al. (1998) examined inclusion levels of 0, 25%, and 50% of WCGF in diets replacing DRC in calves and yearlings. Inclusion of WCGF in both calves and yearlings resulted in faster gains and great efficiency (Richards et al., 1998). No treatment effects were noted for 12th rib fat thickness, yield grade, quality grade, or liver scores (Richards et al., 1998).

WCGF in SFC diets

A survey by Vasconcelos and Galyean (2007), which was evaluated from 42 feedlot consulting nutritionists, noted that 65.52% response preferred SFC to (13.79%) DRC. Steam-flaked corn plays a major role in the cattle feeding industry and had different interactions with byproduct inclusions. A study by Parsons et al. (2007) examined two experiments of feedlot performance and carcass characteristics from diets containing WCGF and different roughage levels in SFC diets. Treatment diets included SFC based diet with 0% WCGF or 40% WCGF, SFC-based diet with WCGF diets containing 9, 4.5 or 0% roughage. Feedlot performance resulted in a linear increase in final BW and DMI in WCGF diets as roughage concentration increased (Parsons et al., 2007). Steers fed WCGF with higher roughage levels had greater ADG than steers fed lower levels of roughage (Parsons et al., 2007). The control group of steers resulted with greatest G:F and lower DMI (Parsons et al., 2007). Parsons et al. (2007) also noted that the control group of steers had a greater feeding intensity (animals present at the bunk after feeding) compared to WCGF steers. No carcass interactions were observed with inclusion of WCGF in SFC diets in experiment one. However, there was a linear effect noticed with inclusion of roughage in WCGF-SFC diets with 9% having the heaviest HCW (Parsons et al., 2007). Furthermore, a quadratic effect was noted for dressing percent and fat thickness within WCGF with roughage inclusion (Parsons et al., 2007). In a second experiment, yearling steers were fed 4 different dietary treatments: SFC-based diet with 9% roughage, SFC with 20% WCGF and 9% roughage, and SFC with 40% WCGF with 9 or 4.5% roughage. In this experiment, the control diet resulted with a lower final BW, ADG and DMI than steer fed WCGF diets (Parsons et al., 2007). Steers fed 20%WCGF vs. 40% resulted in greater G:F (Parsons et al., 2007). Increasing roughage from 4.5% to 9% in the WCGF diet increased DMI and decreased G:F (Parsons et al., 2007). The control group of steers also resulted in lower dressing percentage, HCW, few carcasses grading USDA Choice or greater compared to WCGF diets (Parsons et al., 2007). Carcass adjusted final BW was greater for steers fed WCGF diets compared to the control diet (Parsons et al., 2007). Another study by Sindt et al. (2002) examined combinations of WCGF in SFC-based diets. Dietary treatment design included a control diet containing 0% WCGF, and two WCGF inclusion levels of 30, and 60%. Inclusion of WCGF resulted in an increase in DMI and liver abscesses. Average daily gains and G:F responded quadratically to inclusion of WCGF, with 30% inclusion having the greatest ADG and G:F (Sindt et al., 2002). Sindt et al. (2002) noted a numeric decrease in HCW, DP LM area, marbling score and percent of cattle grading USDA Choice or better for 60% WCGF cattle. Block et al. (2005) evaluated optimal WCGF and protein levels for SFC-based diets in steer calves. Wet corn gluten feed was fed at 0, 20, 30, and 40% of dietary DM. Steers on WCGF had a quadratic response in ADG, G:F DMI, estimated NEg, and HCW to inclusion of WCGF. There were no interactions noted for other carcass characteristics: fat thickness, LM area, marbling, and USDA yield grade with respect to WCGF. Another study by Macken et al. (2004) examined two finishing experiments on the effects of concentration and composition of WCGF in SFC-based diets. Six dietary treatments of WCGF consisting of 0, 10, 20, 25, 30 and 35% replacing SFC on steer calves. Steer fed 0% WCGS had lower DMI versus WCGF concentrations (Macken et al., 2004). There was a tendency for a linear effect on DMI for increasing concentrations of WCGF (Macken et al., 2004). Macken et al. (2004) noted a lack of quadratic response in ADG and G:F in this experiment due to a negative effect with 10%

WCGF inclusion on feed efficiency and dietary NEg and not feeding WCGF at 40%, which was typical (Block et al., 2005; Parsons et al., 2007; Sindt et al., 2002). Carcass characteristics were not different among WCGF treatments compared to the control treatment. In the second experiment, treatment groups were based on ratios of steep to corn bran/germ meal mix in WCGF. Wet corn gluten feed was included in dietary treatments at 25% DM basis and compared to a control with 0% WCGF. Wet corn gluten feed treatments included four concentrations of steep to corn bran/germ meal: 37.5, 41.7, 45.8, and 50%. Cattle daily gains were not different among ratio concentrations (Macken et al., 2004). However, G:F decreased for concentrations of 37.5, 41.7, and 45.8% steep compared to CON (Macken et al., 2004). A quadratic response in DMI was noted for bran to germ meal concentration, with greatest DMI at 41.7 and 45.8% steep concentration (Macken et al., 2004). No differences in HCW, LM area, and marbling scores were noted among treatments (Macken et al., 2004).

Effects of blending byproducts on feedlot animal performance

Location of feedlots prompted opportunities for use of inclusion of multiple byproducts in cattle diets. Three experiments by Loza et al. (2010) examined inclusion of WDGS and WCGF in feedlot cattle finishing diets. In the first experiment, treatment diets included 0% coproduct control diet, 30% WCGF, 30% WDGS, 15% WCGF plus 15% WDGS, or 30% WCGF plus 30% WDGS. Dry matter intake, ADG, and G:F were examined to be intermediate between feeding both coproducts at 30% DM inclusion (Loza et al., 2010). Inclusion of blended coproducts at 30% and 60% yielded increased DMI, greater ADG, G:F, and final BW compared to the control diets, but decreased DMI compared to 30% inclusion with similar G:F (Loza et al., 2010). In the second study, yearling steers were fed treatment rations of included 0, 25, 50 and 75% of a 1:1 blend of coproducts (WCGF:WDGS). Carcass performance by treatments resulted in heavier carcass weights for diets with coproduct inclusion compared to control diets (Loza et al., 2010). Marbling score trended to be higher for 30% WCGF or 30% blended coproduct (Loza et al., 2010). A trend for 12th rib fat was observed to be greatest for cattle fed 30% WDGS and greater yield grades were observed in cattle fed coproducts compared to control diets (Loza et al., 2010). Results from the second study treatments showed a quadratic effect on DMI, ADG and G:F (Loza et al., 2010), greatest ADG, and G:F resulted in feeding 25 and 50% blends of byproducts. Including 75% blended coproducts resulted in similar gains and efficiency to control diet (Loza et al., 2010). Hot carcass weights were observed to be greater for cattle fed 25 and 50% coproducts compared to control and 75% blended diets (Loza et al., 2010). In this study, 12th rib fat thickness was not affected by coproduct inclusion compared to the pervious study (Loza et al., 2010). Marbling score was linearly decreased with increasing levels of blended coproducts. A quadratic effect was observed with increasing blend of coproducts (Loza et al., 2010). In the third study, treatment diets included a control diet with no byproducts and inclusion of WCGF at 30% on DM basis replacing corn. Furthermore, WDGS was included in the WCGF diets at 0, 10, 15, 20, 25, and 30% on DM basis of diet. Results indicated including 30% WCGF resulted in an increase in DMI, ADG and G:F compared to the control diet (Loza et al., 2010). Inclusion of WDGS in WCGF diets resulted in a tendency for a quadratic effect on DMI, and ADG (Loza et al., 2010). Including 15 to 20% WDGS with 30% WCGF resulted in the greatest ADG. Inclusion of 12.2% WDGS with 30% WCGF (42.2% coproduct inclusion) resulted in maximal BW gain (Loza et al., 2010).

Steers fed WCGF at 30% DM resulted in heavier carcass weights compared to 0% WCGF (Loza et al., 2010). A quadratic effect was observed in 12th rib fat with increasing level of WDGS in treatment diets and also observed in calculated YG.

A study by Homm et al. (2008) evaluated feeding elevated levels of dried distillers grains plus solubles and soybean hulls (SH) to feedlot steers. Steers were fed a high byproduct diet, which included DDGS at 49% DM and SH at 35% DM for 56, 84, 112, 140, or 196 d then fed a second concentrate diet consisting of 25% DDGS and 57% high moisture corn. Adjusted final BW and ADG increased linearly as length of time on DDGS-SH diet increased with greatest ADG achieved at 196 d at 1.61 kg/d (Homm et al., 2008). Animal efficiency resulted in a linear decrease as length of time on DDGS-SH diet increased (Homm et al., 2008). Dry matter intake increased linearly as length of time on DDGS-SH diet increased (Homm et al., 2008). Cattle feed DDGS-SH diet for 196 d tended to result in greater adjusted BW compared to steers fed DDGS-SH for 56 d. whereas, cattle fed DDGS-SH for 196 d had increased ADG versus steers fed DDGS-SH for 56 d (Homm et al., 2008). Steers on DDGS-SH diet for 196 d had great DMI compared to 56 d steers. Homm et al. (2008) also reported a linear increase in liver scores and HCW as days on DDGS-SH diet increased. Increasing days on DDGS-SH responded in a quadratic effect on marbling and overall maturity of carcasses. No differences were seen in 12th rib fat thickness, LM area, or USDA yield grade (Homm et al., 2008). Homm et al. (2008) ran an economic comparison on the study, which resulted in no difference in COG for length of time on DDGS-SH diet.

Fecal characteristics of feedlot cattle

Little research has been published evaluating fecal characteristics of feedlot cattle or pen condition. With growing environmental concerns, nutrient excretion from feedlot animals has gain publicity with particular interest in N, P, and S nutrients. Characterizing feces becomes important from a managerial standpoint for proper pen conditions to insure animal welfare and performance. Ireland-Perry and Stallings (1993) evaluated dietary treatment effect on fecal consistency in dairy cattle. Diets were formulated to contain 17 or 25% ADF and 15 or 22% of CP supplemented with soybean meal or 22% corn gluten and soybean meal. Fecal consistency (Table 1-3) was evaluated using a four-point visual observation scale. Results indicated that lower dietary fiber reduced fecal pH, score, NDF, and ADG. However, this increased fecal DM and starch. Fecal score and fecal DM decreased with higher percentage of soybean meal. Dietary forage source affected fecal DM, NDF, ADG, and starch however, not pH or fecal score. Another fecal evaluating scale was proposed by Larson et al. (1977) for guidelines toward more uniformity in measuring and reporting calf experimental data. Numeric values on fecal scoring was opposite compared to Ireland-Perry and Stallings (1993) (Table 1.3) with lower number resulting in more firm fecal consistency and higher numbers a more loose fecal consistency. A study by Spiehs and Varel (2009) measured nutrient excretion from cattle fed diets containing 0, 20, 40, or 60% WDGS in DRC-based diets. Total nutrient phosphorus, nitrogen, and sulfur intake increased linearly with increasing amount of WDGS in diet.

Impacts of heat-stress on feedlot performance

What is heat stress?

High heat and humidity environments can be detrimental to productivity in animal agriculture. (St-Pierre et al., 2003). High animal agriculture producing states have felt the hardships of environmental extremes on production. St-Pierre et al. (2003) modeled beef production loses of $369 million a year in heat stressed conditions. St-Pierre et al. (2003) also stated that heat stress results from a negative balance between the net amount of energy flowing from the animal to its surrounding environment and the amount of heat energy produced by the animal. Many factors go into consideration when an animal experiences heat stress such as: temperature, humidity, geneotype (bos indius, bos tarus), coat color, health status, stage of production (i.e. lactation, estrus), degree of acclimation, access to water and shade, days on feed, depth of manure, and water trough temperature (Gaughan et al., 2008). All of these factors will affect cattle during times of high heat and humidity.

Methods of handling heat stress

Heat production can be divided into four components: basal metabolism, heat of digestion, heat of activity and production metabolism (heat from the production of milk, eggs, lean muscle tissue, etc.) (Brown-Brandi, 2008). Heat loss from the body has been labeled as either respiratory latent heat loss or surface latent heat loss. Whereas, latent heat is described as heat lost by evaporation of moisture from the skin surface or respiratory tract of animals. Cattle only loose approximately 22% of their latent heat through panting (Brown-Brandi, 2008). Individual animals vary greatly in the ability to handle heat stress. When exposed to extreme heat conditions cattle decrease DMI, which is thought because this reduces heat production from foodstuff (Brown-Brandi, 2008; Davis et al., 2003; Gaughan et al., 2008; Mader and Davis, 2004; Mader et al., 2006; Reinhardt, 1994; St-Pierre et al., 2003). Cattle that tend to be affected from heat stress the most are the cattle that have a higher degree of fat cover (finished cattle) or animals that have health implications. Management strategies have changed how cattle are handled during times of high heat stress. Selection of coat color impacts animal's ability to handle heat stress. Davis et al. (2003) determined that black hided steers had higher tympanic temperature vs. white haired steers proving that a coat color and time of day interaction was seen in heat stressed animals, which varied from 0.16°C to 0.26°C during the time of the day (overall avg. of 0.14°C between coat color). Feedlots are now engineered to help mitigate heat on animals by increasing air flow, adding shaded areas for animals to rest, adding sprinklers to increase heat loss from skin evaporation or dissipaion in the ground. Studies have evaluated feeding methodologies for mitigation of heat stress. Time of feeding and changing energy load in ration have shown positive performance in cattle (Mader and Davis, 2004; Mader et al., 2006). Although, from an economic and biological standpoint, cattle being switched from a high energy diet to a higher forage based diet would take longer to finish in the feedyard and thus have a lower performance and conversion costing more to finish. When it comes to the nutrition of heat-stressed animals little research has been done studying the metabolic effects of concentrate load on heat of production. One could suggest that a lower energy load capacity would produce less heat (Davis et al., 2003; Mader and Davis, 2004; Mader et al., 2006; Mader et al., 2002).

Summary of Literature

The ethanol industry has forever changed the beef feeding systems by offering high quality byproducts for ration diets. Wet distiller's grains plus solubles has improved ADG, F:G, and DMI for cattle on DRC diets when included up to 40% DM basis (Corrigan et al., 2009; Erickson et al., 2010; Ham et al., 1994; Klopfenstein et al., 2008; Vander Pol et al., 2008). The over abundant supply cannot be supported by local demand and thus must be dried for transportation across greater distances. Drying distillers grains plus solubles seems to lower the NEg value of the feedstuff, which was attributed to the drying process (Klopfenstein et al., 2008). Optimum level of inclusion of DDGS is around 20 to 40% on a DM basis (Erickson et al., 2010; Klopfenstein et al., 2008). However, the same paradigm does not apply for SFC-based diets. Steam-flaked corn has a higher feeding value compared to DRC-based diets due to the process of flaking the kernel. This process allows optimal degradation by the ruminal microbes of starch component of the kernel, which transfer to utilizable energy by the host animal. Byproduct inclusion in SFC-based diets seems to be optimal at approximately 15% of dietary DM (Corrigan et al., 2009; Erickson et al., 2010; Klopfenstein et al., 2008; May et al., 2010). There seems to be no clear reason why performance doesn't increase with greater amounts of DGS in SFC diets.

The wet milling industry is a smaller industry compared to the ethanol industry and is growing along with demand of wet milling products. From the wet milling industry, WCGF and WCGM are available for feedstuffs in diets. Wet corn gluten feed is different from wet distillers grains by containing a highly digestible fiber portion, higher ruminally degradable protein, and higher starch composition (Stock et al., 2000). Dietary inclusion seems to be variable for optimum performance, which was attributed to milling plant composition of WCGF and steep ratio (Stock et al., 2000). In DRC-based diets, WCGF was found to be beneficial when included up to 50% dietary DM (Richards et al., 1998). However, dietary inclusion seems to be lower in SFC-based diets with optimal ADG and G:F achieved at replacing SFC with approximately 25-30% WCGF on a DM basis.

Combining WCGF and DGS in diets seems to be more tolerable at higher levels than either byproduct alone. A major benefit of including both in a diet would be current supply level. If an operation runs out of one commodity then they can utilize the other rather than adding more corn or switching rations. This would keep the animal on a more consistent intake minimizing DMI difference and digestive upsets.

Few studies have been performed on dietary effects on fecal characteristics or dietary effects on pen condition. Larson et al. (1977) produced guidelines for evaluation of fecal characteristics, which severs as a tool for research and/or pen maintenance. Spiehs and Varel (2009) showed with increasing dietary nutrient composition there will be an increase in fecal nutrient composition. Thus, diets correlate to fecal characteristics, feeding higher protein diets increases viscosity of feces.

Furthermore, feedlot sectors have been battling environmental effects on cattle production. Heat plays a major summer role in the southern plains on cattle performance resulting in a loss to the producer. St-Pierre et al. (2003) stated heat stress causes economic losses of 369 million for beef produces. Feedlots will schedule operations to accommodate for cattle comfort. Many different heat abatement operations have been evaluated for mitigating heat stress such as: shade, feeding time, cattle movement times, and dietary effects.

In conclusion, byproducts (DGS and WCGF) can offer advantages in animal performance and cost of gains (when byproducts are lower than the cost of corn). Byproducts have been credited for alleviating incidence of ruminal acidosis (Klopfenstein et al., 2008; Krehbiel et al., 1995; Scott et al., 2003). Byproducts will vary between facilities due to their own protocol for production. Cattle feeders and nutritionists must be aware of these variations in order to achieve optimal animal performance. Grain type (SFC, DRC, HMC) in ration will have an effect on optimal dietary inclusion of byproducts. Increasing byproduct inclusion will have an effect on fecal consistency, which will effect pen/lot management. Rising temperatures have caused economic losses to beef producers and ration formulation could potentially play a role in heat stress management. Therefore, feeding a combination of DDGS and WCGF at high levels may have beneficial animal performance effects from heat stress, as well as, greater potential profit margins due to the cheaper cost of byproducts.

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Table 2.1 Milling yields[1]

Item	Portion of Corn[2]
Steep liquor	6.5
Germ	7.5
Bran	12.0
Gluten	5.6
Starch	68.0
Losses (volatiles, etc.)	0.4
Total	100

[1] Adapted from Blanchard (1992).

[2] Parts dry substance by weight per 100 parts corn dry substance

Table 2.2 Nutrient composition of selected corn milling co-products[1]

Feedstuff[2]	DRC[3]	WCGF-A	WCGF-B	DDGS[4]	WDGS[4]	CCDS[4]	MDGS	Steep[5]
DM	90	44.7	60.0	90.4	34.9	35.5	46.2	49.4
CP, % of DM	9.8	19.5	24.0	33.9	31.0	23.8	30.6	35.1
UIP, % of CP	60	25	25	65	65	20	65	10
P, % of DM	0.32	0.66	0.99	0.51	0.84	1.72	0.84	1.92
NEg, Mcal/lb[6]	0.70	0.70	0.78	0.78	0.91	0.87	0.85	0.95

[1]Adapted from Erickson et al., (2010)
[2]DRC= dry rolled corn with NRC (1996) values, WCGF-A= wet corn gluten feed, WCGF-B = Cargill Sweet Bran® wet corn gluten feed, DDGS= dried distillers grains + solubles, CCDS = condensed corn distillers solubles (corn syrup), MDGS = modified wet distillers grains + solubles, steep is steep liquor from wet milling plants.
[3]DRC values based on NRC (1996) values with approximately 3500 samples.
[4]Values from spring 2003, from only one plant in Nebraska that produces DDGS, WDGS, and CCDS with a standard deviation based on weekly composites.
[5]DM values represent variation from daily composites for a 60-d period. Other nutrients are based on monthly composites for 2002 and half of 2003.
[6]NEg values are based on animal performance relative to DRC for all co-products. DDGS, WDGS, CCDS, and MDGS energy (NEg) value are dependent on dietary inclusion and should be used only as a guide.

Table 2.3 Fecal score consistency[1]

Score[2]	Description
1	Runny: liquid consistency, splatters on impact, spreads readily.
2	Loose: may pile slightly and spreads, spatters moderately on impact and setting.
3	Soft: firm but not hard, piles but spreads slightly on impact and settling.
4	Dry: hard, dry appearance original form not distorted on impact and settling.

[1]adapted from Ireland-Perry and Stallings (1993).

[2]Larson et al., (1977) fecal scores would go as follows: 4,3,2,1 with the order of the description above.

CHAPTER III

BLENDED BYPRODUCT FEEDS IN FINISHING RATIONS ON PERFORMANCE, CARCASS, AND FECAL CHARACTERISTICS OF YEARLING HEIFERS

Abstract

This experiment replaced part or all of the concentrate in a dry-rolled corn based feedlot ration with a 1:1 blend of byproducts (Sweet Bran® and dried distillers grains plus solubles; DDGS). Parameters evaluated included growth performance, carcass characteristics, fecal characteristics, and bunk pad samples. Heifers (n = 108; Initial BW = 324 ± 13kg) were blocked by BW, randomized to treatment, and fed for 142 d. Treatments were control (CONT, 11% DDGS), intermediate with 22% Sweet Bran® and 22% DDGS (INTERM), and all byproduct with 44% Sweet Bran® and 44% DDGS (ALL). During d 29 to 56, a time of severe environmental heat, ALL quadratically increased ADG and G:F ($P < 0.03$) with ALL being 14% and 19% higher than CONT, respectively. Average daily gains were similar for all other periods. There was a linear increase in overall G:F with increasing byproduct inclusion ALL ($P = 0.03$) using live and carcass adjusted final BW.

There was a trend ($P = 0.09$) for a quadratic increase in HCW which was 3% greater ($P = 0.03$) for byproduct inclusion than the control, with no other differences in carcass merit measures. Rectal fecal grab samples were taken every weigh period for pH, fecal scoring, and DM content. Further analysis by treatment was compared by taking concrete bunk pad samples at weight periods starting d 56 and determining DM and density. For all weigh days after d 0 fecal pH increased linearly ($P < 0.001$) with increasing byproduct blend inclusion. Fecal scores increased linearly (decreased consistency, $P < 0.03$) with increased byproduct blend inclusion after d 14 grab DM results. Pad sample DM decreased linearly ($P \leq 0.05$) on d 56, 112, and 142 and tended to decrease linearly on d 84 ($P = 0.06$). This data indicates that replacing part or all of the concentrate in a dry-rolled corn based feedlot ration with a 1:1 blend of Sweet Bran® and DDGS increases feed efficiency and HCW without altering ADG. Increasing the 1:1 blend also increases fecal pH, fecal scores, and decreases fecal and pad sample DM.

Key words: distillers grains, corn gluten feed, waste management, cattle

Introduction

Due to wet and dry mill processing of grains, byproducts play a significant role in cattle feeding. Byproducts provide an excellent source of protein and with current elevated corn prices, they could be a price competitive. Research suggests that distillers grains can be included in feedlot diets up to 40% DM with no adverse effects in performance (Buckner et al., 2008; Ham et al., 1994; Homm et al., 2008; Klopfenstein et al., 2008; Lodge et al., 1997). However, limited research has been published feeding diets where corn concentrate is completely replaced with byproducts. Homm et al. (2008) concluded that cattle could be fed on an all byproduct diet (40% DDGS and 35% soybean hulls); however, no economic advantages were observed in their study. Due to current high prices of grains and increasing supplies of byproducts (corn and sorghum wet and dry-distillers grains), further evaluation of high byproduct concentrations may be justifiable. The objectives of this experiment were to examine the effects of byproduct inclusion on animal performance, carcass characteristics, and fecal characteristics from a control diet (CONT) with 10% corn DDGS or diets 22% WCGF and 22% corn DDGS (INTERM) or 42% WCGF and 42% corn DDGS (ALL) replacing corn and liquid supplement.

Materials and Methods

This experiment was conducted at the Willard Sparks Beef Research Center at Oklahoma State University through the Department of Animal Science. All animal use procedures were approved by the Oklahoma State University Institutional Animal Care and Use Committee.

Cattle Management

Crossbred yearling heifers were received during a three week period in May of 2011. Upon arrival initial body weights were obtained and animals were noted for hide color, horns, and any abnormalities (lameness, pinkeye, etc.). Cattle received vaccination against clostridial toxins, IBR, PI3, BRSV, BVD type I and II (Caliber 7 and Express 5; Boehringer Ingelheim, St. Joseph, MO), and external parasites (Ivomec Plus; Merial Animal Health, Duluth, GA). Animals were later checked for pregnancy by a licensed veterinarian. Heifers that were greater than 120 d bred were pulled and not allocated to the experiment. Heifers that were less than 120 d bred received a 5 ml dinoprost tromethamine (Lutalyse, Pfizer Animal Health, New York City, NY) injection. Heifers were weighed on d -1 (n = 108) to obtain BW for allocation to treatment pens. On d 0 heifers were weighed and implanted with 80 mg of trenbolone acetate and 8 mg of estradiol (Revalor IH Merck Animal Health, Lawrence, KS) and sorted into treatment pens. Heifers were placed in 4.57 m x 15.24 m pens with a 4.47 m fence-line feed bunk and a 4.57 m deep concrete apron extending into the pen. The feed bunk and apron were covered by a metal awning. There were a total of 18 pens with 6 blocks, 1 pen per treatment and 6 head per pen. Treatments included control (CONT), intermediate (INTERM), and all byproduct finishing rations (ALL; Table 3.1). Rations were formulated to contain similar metabolic energy. Cattle were individually weighed across a certified scale before AM feeding every weigh period. Weigh periods consisted of d 0, 14, 28, 56, 84, 112, and 142.

On d 84, heifers were re-implanted with 140 mg of trenbolone acetate, 14 mg of estradiol USP and 29 mg of tylsin tartrate (Component TE-H Elanco, Overland Park, KS). On d 117, 6.83 g per ton of zilpaterol hydrochloride (Zilmax; Merck Animal Health, Lawrence, KS) was formulated into each treatment ration supplement and fed for 22 d followed by a 3 d withdrawal with original treatment supplement. Cattle were individually weighed at 0500 h on d 142 and shipped 110 km to Creekstone Farms, Arkansas City, KS for harvest. Harvest and carcass data was collected by trained plant personnel from the Creekstone Farms. For each weigh period, the individual animal scale was validated using 22.67 kg certified weights. A pencil shrink of 4% was applied to all BW.

Feed and Bunk Management

Cattle were fed twice daily at 0700 and 1300 h. Cattle were adapted using a 2 ration blend method, a common 60% concentrate diet and treatment diet. Bunks were read daily by trained personnel at 0600 and 1700 h, feed calls made to achieve a slick-bunk approach according to facility protocol. Feed refusals were obtained on weigh days and during inclement weather conditions. Feed refusals subsamples (200 g) were taken and dried in a forced-air oven at 60°C for 48 h. Diets were mixed in a Roto-Mix 84-8 trailer type mixer. Every morning, manure, hair, etc. were removed from bunks. A 75.7 L concrete water tank (Model J 360-F, Jonson Concrete, Hastings, NE) was shared between two pens and was cleaned 3 times/week throughout the 142 d experiment. Byproducts utilized were corn DDGS (Abengoa Energy, York NE and Nebraska Energy, Aurora, NE) and Sweet Bran (Cargill Animal Nutrition, Dalhart, TX).

Fecal Sampling

For this experiment rectal fecal grab samples were taken from heifers restrained in a hydraulic squeeze chute at each weigh day. Fecal scores and pH were analyzed immediately after each sample was taken. Fecal scores were assigned (Table 3.2) using methods adapted from Larson et al. (1977) and Ireland-Perry and Stallings (1993). Fecal grab sample pH was analyzed by using a VWR pH meter with a soil probe (SP70P, Batavia, IL). Fecal grab samples were taken to achieve at least 4 of the 6 head to get a pen average. Fecal grab samples (approximately 10 g) were frozen and stored for DM. Fecal grabs were weighed and placed into a 60°C oven for approximately 48 h for DM analysis.

Pad/Pen Measuring

Pen measurements were taken every week in 5 areas of the pen to determine a pen average. After week 7, pen measurements were switched to pad measurements for a better representation of dietary influence on pen condition. Pad measurement samples were taken the day before weigh day at each weigh point. A 4.73 L container was filled with excrement from the pad and weighed for calculation of pad density. Approximately 500 g subsample was taken and placed in a 60^{o}C forced-air oven and dried for 72 h to determine DM content

Experimental Design and Statistical Analysis

The experimental design was a randomized complete block design with 6 blocks of heifers and 1 treatment replication per block. Performance data and carcass data were analyzed using the MIXED procedures of SAS 9.3. (SAS Institute Inc., Cary, NC), using pen as the experimental unit; and block as a random effect. Means were evaluated with linear, quadratic, and byproduct vs. control contrasts. Significance was considered when $P \leq 0.05$ and trends were considered when $P > 0.05$ and ≤ 0.10 Carcass weights from cattle that were noted as having severe amount of carcass trim due to carcass contamination or abscessed livers and dressing percentage below the pen average were adjusted back to the average dressing percentage for the pen. Carcass adjusted final BW, ADG, and G:F were calculated by using the average dressing percentage of all the cattle in the study (65.90%).

Results and Discussion

Performance

There was no differences in ($P > 0.15$) in initial or final BW (Table 3.3). Carcass adjusted BW had a tendency ($P = 0.10$) to increase linearly and was greater for byproduct diets than CONT ($P = 0.13$). Overall DMI resulted in a quadratic effect ($P \leq 0.05$) with INTERM having the highest and ALL having the lowest DMI. Using live weights and carcass adjusted weights resulted in a quadratic tendency ($P \leq 0.08$) for ADG with INTERM higher than the other treatments. Feed efficiency on a live and carcass adjusted basis increased linearly ($P < 0.03$) with increasing byproduct inclusion. Carcass adjusted ADG and G:F were higher ($P < 0.03$) for byproduct treatments than CONT. Calculated NE_m from performance tended ($P = 0.08$) to be greater with byproduct inclusion while NE_g was not different ($P > 0.18$)

Loza et al. (2010) conducted a series of experiments looking at replacement of a combination of dry-rolled and high-moisture corn with byproducts or combination of byproducts. Loza et al. (2010) reported that DMI, ADG and G:F responded quadratically with a 1:1 blend of WDGS and WCGF included in the diet at 25, 50 and 75% of diet. Similar DMI responses were reported in a second experiment feeding blended byproducts replacing 30 or 60% of corn in the diet. Feed efficiency and ADG increased up to the 50% inclusion rate and then declined to a level similar to the control diet. In our experiment, a fat containing supplement was used in attempt to eliminate differences in dietary EE. This resulted in our ALL DMI being the lowest, but a similar response in ADG to the feeding of levels up to 75% of the diet. Data from Richards et al. (1998) supports current data, whereas, increasing inclusion of WCGF increased ADG and produced more efficient cattle when fed either 25 or 50% WCGF in diet. In contrast, both G:F and DMI responded quadratically when DDGS was included up to 40% (Buckner et al., 2008; Klopfenstein et al., 2008). Increase in performance could be attributed to a decrease in acidosis. Research supports that including byproducts such as WCGF or WDGS/DDGS has potential to lower the incidence of subacute acidosis (Farran et al., 2006; Klopfenstein et al., 2008; Krehbiel et al., 1995; Loza et al., 2010; Stock et al., 2000). Thus including higher amounts of byproducts would lower the incidence of acidosis and improve animal performance compared to cattle on lower or no byproduct diets.

During d 29 to56 of the experiment, cattle experienced a 28 d of thermal heat index value (THI of $\geq$ 74; Figure 3.1), which was reported by Eigenberg (2007) as being in the alert stage for heat stress. During the period, cattle on ALL treatment maintained performance whereas, INTERM had a 0.42 kg per d decrease and CONT had a 0.28 kg per d decrease in ADG resulting in a quadratic response ($P < 0.01$) in G:F. Over the entire feeding period cattle were subjected to 92 d of greater than 74 THI. Over the finishing period the increase in performance with increasing byproduct inclusion could lower the incidence of ruminal acidosis, increasing animal performance. In addition, lower ruminal temperature could potentially lower an animal's thermal body temperature which could impact an animal's performance. In a recent study, Wahrmund et al., (2012) reported that ruminal temperature had a negative association with ruminal pH, which is further supported by AlZahal et al. (2008) in dairy cattle fed high-starch diets, which exhibited a lower ruminal pH and high ruminal temperature compared to control cattle. Furthermore, nutrient composition of diets showed increasing blended byproducts increased EE content. Diets were formulated to balance EE levels, however fat ranged from 4.10 to 5.67%. Some variation in fat % could be attributed to sampling error. Over the finishing period, higher levels of fat may have increased performance for INTERM and ALL. From these data, animal performance could have been enhanced during the period of THI by byproduct inclusion, if inclusion of increased byproducts potentially lowers heat stress and potentially increases calorie density of diets. Interim data for all other periods and performance measures were not different ($P > 0.05$).

Carcass

There was a tendency (*P* = 0.09; Table 3.5) for a quadratic effect in HCW with inclusion of blended byproducts resulting in heavier carcasses (*P* = 0.03). Greater HCW was attributed to cattle of ALL maintaining performance during a period of heat stress (THI > 74) and INTERM having compensatory gain after heat stress period, d 29 to 56. Similarly, Farran et al. (2006) reported a tendency for an increase in HCW when including WCGF at 35% on DM basis. Buckner et al., (2008) reported a quadratic response in HCW with increasing DDGS levels of up to only 40%. There was a linear increase in DP (*P* = 0.02) with ALL having a 1.2 percentage unit increase over CONT. This contrasts Loza et al. (2010) findings where DP was not affected within dietary treatment of WCGF with WDGS when WCGF was fed at 30% and WDGS was included at 10, 20, 25 and 30% with WCGF. A quadratic response was reported by Parsons et al. (2007) in DP when WCGF was fed at 20 and 40% in SFC based diet, which contrasts current data. Carcass characteristics could be attributed to a high heat period during the feeding phase, whereas, blended byproduct treatments had greater performance reflective in heavier carcasses. There were no significant differences (*P* > 0.19) among treatments for marbling score, 12th rib back fat, LMA, USDA yield grad, or quality grade (*P* > 0.10). Loza et al., (2010) reported a linear decrease in marbling score with increasing level of a 1:1 blend of WCGF and WDGS from 25, 50, and 75% of diet, which also contrasts the current study.

Fecal and Pad

At the beginning of the experiment (d 0) fecal pH were not different between treatments ($P > 0.23$; Table 3.6). Fecal pH increased linearly ($P < 0.001$) with increasing blended byproduct at all subsequent sampling days. Fecal scores were not affected by ($P > 0.10$) diet treatment d 0 and 14 respectively. Increasing amount of blended byproducts linearly increased ($P \leq 0.03$) fecal scores on sampling points from d 28 to the end of the experiment. Rectal fecal grab sample DM (Table 3.7) linearly decrease ($P \leq 0.03$) in DM with increasing byproduct inclusion. Pad sample (Table 3.8) DM linearly decreased ($P \leq 0.05$) with increasing byproduct on d 56, 112, and 142 and tended ($P = 0.08$) to decrease on d 84. Pad sample density was not different on d 56 and 84 ($P > 0.09$), but at d 112 density tended to increase linearly ($P = 0.06$) and by d 142 increased linearly ($P < 0.01$) with increasing byproduct. Increased fecal pH was also reported by Sindt et al. (2002) when WCGF was fed at 30 or 60% of the diet. Data for a fecal scoring system with the feedlot sector is limited. Protein and fiber content of the diet have been implicated in decreasing the viscosity of cattle stools. Data from Ireland-Perry and Stallings (1993) was similar to current data, whereas, higher protein diets resulted in reduced fecal consistency and decreased fecal DM. In the present experiment, ADF increased with increased byproduct inclusion. As the feeding phase went along CONT as-is density numerically decreased, whereas, ALL seemed to maintain its density. Later in the feeding phase there were significantly long periods of no precipitation allowing for pen conditions for CONT to dry and be more desirable, while INTERM and ALL remained moist to runny. Thus, when increasing levels of wet byproduct in the diet, DM and consistency of the fecees will be reduced while density of the feces will increase. These changes may have implications on management required for maintain pen conditions as well as feces removal and hauling.

Implications

Increasing blended byproducts tended to increase gain and increase efficiency. Increasing level of byproduct in diets will decrease fecal DM and increase fecal score. Density of excrement collected from the pad increased with increasing wet blended byproducts in diets, which may affect pen management methods to maintain animal welfare and performance and increase weight of material removed from the pen.

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Table 3.1 Treatment diet and nutrient composition

Item	CONT[1]	INTERM[1]	ALL[1]
Dry-rolled corn	63.52	35.27	-
Sweet Bran®, Wet corn gluten feed	-	21.23	42.45
Dried distillers grains plus solubles	10.62	21.23	42.45
Prairie hay	9.00	9.00	9.00
Dry supplement	6.10[2]	6.10[3]	6.10[3]
Liquid supplement	10.76	7.17	-
Analyzed nutrient content[5], DM basis			
Ration, %DM	82.00	79.00	77.00
Crude Protein, %	14.77 (0.42)	17.97 (1.02)	22.40 (0.59)
NEm, Mcal/kg	2.27 (<0.01)	2.25 (<0.01)	2.16 (<0.01)
NEg, Mcal/kg	1.57 (<0.01)	1.54 (<0.01)	1.48 (<0.01)
ADF, %	7.48 (0.56)	9.65 (0.41)	13.75 (0.62)
NDF, %	18.98 (0.64)	26.75 (0.76)	39.33 (0.89)
TDN	91.10 (0.64)	89.97 (0.05)	87.20 (0.85)
Crude Fat,%	4.10 (0.11)	4.55 (0.15)	5.67 (0.23)
Calcium,%	0.67 (0.13)	0.85 (0.27)	0.49 (0.14)
Phosphorus,%	0.43 (0.01)	0.66 (0.03)	0.96 (0.02)
Magnesium,%	0.20 (0.00)	0.25, (0.01)	0.34 (0.01)
Potassium,%	0.95 (0.02)	1.12 (0.03)	1.36 (0.02)
Sulfur,%	0.24 (0.01)	0.30 (0.01)	0.44 (0.01)
Sodium,%	0.14 (0.02)	0.20 (0.03)	0.24 (0.02)
Iron, mg/kg	174.50 (32.45)	201.50 (44.10)	165.17 (9.47)
Manganese, mg/kg	43.83 (4.88)	52.17 (12.72)	43.33 (10.95)
Copper, mg/kg	12.00 (1.26)	17.17 (3.06)	14.50 (3.99)
Zinc, mg/kg	105.83 (30.88)	91.83 (25.76)	111.33 (26.36)

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.

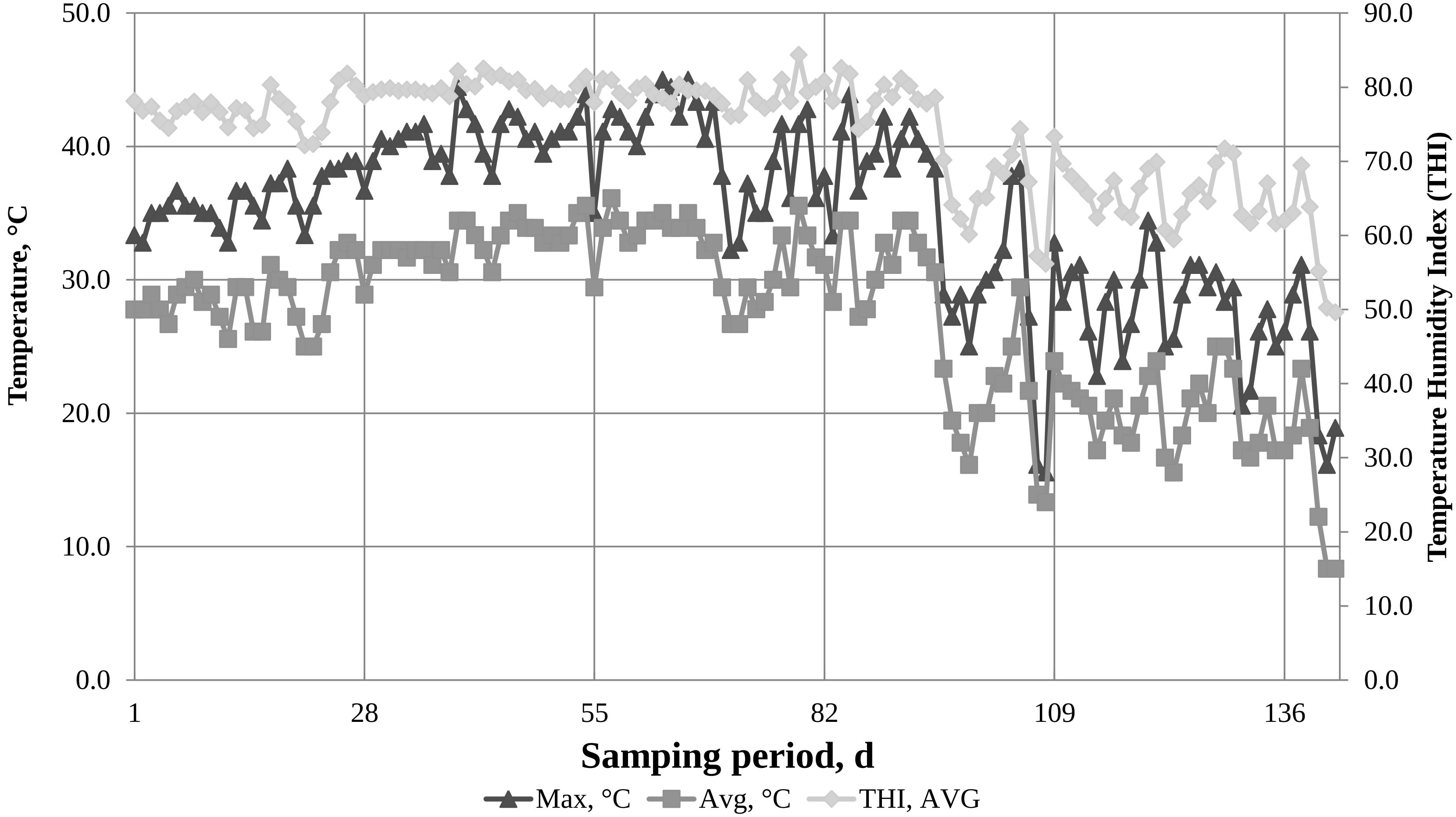
[2]Formulated to contain 28.04% limestone, 1.64% KCl, 0.88% MgO, 4.92% NaCl, 3.28% Urea, 39.69% ground corn, 20.49% wheat midds, 0.09% $CuSO_4$, 0.07% MnO, 0.01% Se, 0.33% $ZnS0_4$, 0.12% Vitamin A, 0.01% Vitamin E, 0.27% Rumensin-90, 0.166% Tylan-40.

[3]Formulated to contain 28.04% limestone, 4.92% NaCl, 3.28% Urea, 41.21% ground corn, 20.48% wheat midds, 0.10% $CuSO_4$, 0.07% MnO, 0.01% Se, 0.25% $ZnS0_4$, 0.11% Vitamin A, 0.01% Vitamin E, 0.27% Rumensin-90, 0.166% Tylan-40, 1.08% Thiamine 10.

[4]Synergy 19/14 (Westway Feed Products, New Orleans, LA).

[5]Samples were chemically analyzed by Servi-Tech Labs Inc., Dodge City, KS. Standard deviations in parenthesis.

Figure 1. Weather data from May 31 to October 18, 2011[1,2]



[1]Data was adapted using methods from Mader et al., (2002).
[2]Data derived from http://www.srh.noaa.gov/oun/climate/get_f6.php?city=swo&month=08&year=2011&fontsize=3
Latitude: 36.136696 N, Longitude: 97.11369 W

Table 3.2 Fecal scoring sytem[1]

Fecal Score	Description
Score 1	Firm, hard, and dry appearance; described as a cow on dry hay.
Score 2	Slightly less firm and hard, having the consistency of cookie dough.
Score 3	Relatively soft and moist; between **Score 2** and **Score 3**.
Score 4	Loose, very moist and runny consistency of pancake batter.
Score 5	Very thin and watery; could not be captured in an open hand; consistency of orange juice.

[1]Adapted from Ireland-Perry and Stallings (1993); Larson et al. (1977).

Table 3.3 Effect of byproduct blend inclusion in finishing diet on animal performance

Item	Experimental Diets Treatment[1]				*P*-value		
	CONT	INTERM	ALL	SEM	Linear	Quadratic	CONT vs Byproduct[2]
Pens	6	6	6	-	-	-	-
Animal enrolled	36	36	36	-	-	-	-
Days on feed	142	142	142	-	-	-	-
Performance							
Initial BW, kg	323	323	324	14	0.58	0.77	0.74
Final BW, kg	538	552	542	14	0.66	0.15	0.32
Carc. Adj. Final BW, kg	533	552	547	15	0.10	0.10	0.03
Carc. Adj. ADG	1.48	1.61	1.57	0.04	0.11	0.08	0.03
Carc. Adj. G:F	0.148	0.155	0.166	0.004	0.0002	0.42	0.0014
DMI, kg/d	10.01	10.44	9.49	0.36	0.19	0.05	0.89
ADG, kg/d	1.52	1.61	1.54	0.04	0.68	0.10	0.24
G:F	0.152	0.155	0.163	0.005	0.03	0.42	0.11
NE_m, Mcal/kg[3]	1.87	1.89	1.98	0.03	0.12	0.24	0.08
NE_g, Mcal/kg[3]	1.31	1.25	1.33	0.04	0.73	0.18	0.69

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.

[2]Contrast between Control and INTERM + ALL.

All live weights calculated with 4% pencil shrink.

[3]NEm=Net energy maintenance, NEg= Net Energy gain. Values calculated by using equations from Beef NRC., (2000).

Table 3.4 Effect of byproduct blend inclusion in finishing diet on animal performance by period

	Experimental Diet Treatment[1]				*P*-value		
Item	**CONT**	**INTERM**	**ALL**	**SEM**	**Linear**	**Quadratic**	**CONT vs. Byproduct[2]**
Day 0-14							
DMI, kg/d	8.70	8.84	8.94	0.46	0.50	0.94	0.53
ADG, kg/d	1.64	1.37	1.59	0.17	0.82	0.21	0.41
G:F	0.198	0.155	0.182	0.026	0.49	0.10	0.16
Day 0-28							
DMI, kg/d	9.62	9.99	9.37	0.54	0.55	0.19	0.87
ADG, kg/d	1.62	1.68	1.51	0.09	0.40	0.31	0.82
G:F	0.173	0.169	0.163	0.012	0.43	0.88	0.54
Day 29-56							
DMI, kg/d	10.08	10.35	9.57	0.42	0.28	0.21	0.77
ADG, kg/d	1.34	1.26	1.53	0.09	0.04	0.03	0.49
G:F	0.135	0.124	0.161	0.012	0.003	0.002	0.23
Day 57-84							
DMI, kg/d	10.05	10.75	9.68	0.40	0.46	0.06	0.71
ADG, kg/d	1.44	1.73	1.62	0.10	0.21	0.13	0.07
G:F	0.144	0.161	0.170	0.011	0.11	0.79	0.13
Day 85-112							
DMI, kg/d	10.09	10.64	9.59	0.31	0.28	0.05	0.93
ADG, kg/d	1.31	1.57	1.41	0.12	0.48	0.09	0.15
G:F	0.129	0.148	0.146	0.011	0.20	0.37	0.13
Day 113-142							
DMI, kg/d	10.21	10.52	9.32	0.40	0.12	0.12	0.54
ADG kg/d	1.85	1.80	1.62	0.10	0.10	0.58	0.23
G:F	0.182	0.170	0.174	0.008	0.49	0.45	0.33

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.

[2]Contrast between Control and INTERM + ALL.

All live weights calculated with 4% pencil shrink.

Table 3.5. Effects of byproduct blend inclusion in finishing diet on carcass characteristics

	Experimental Diet Treatment[1]				*P*-value		
Item	**CONT**	**INTERM**	**ALL**	**SEM**	**Linear**	**Quadratic**	**CONT vs Byproduct[2]**
HCW, kg	351	364	360	10	0.10	0.09	0.03
Dressing Percentage	65.2	66.0	66.4	0.31	0.02	0.66	0.02
Marbling Score[3]	390	417	392	21	0.95	0.33	0.58
12th Rib-fat, cm	1.32	1.27	1.37	0.13	0.78	0.59	0.97
Ribeye area, cm^2	93.94	94.84	95.35	2.00	0.50	0.93	0.53
USDA Yield Grade	2.60	2.67	2.71	0.19	0.66	0.94	0.67
Quality Grade							
Premium	13.89	22.22	19.44	0.07	0.54	0.49	0.41
>Choice	52.80	70.33	58.68	0.11	0.64	0.19	0.27
Choice-	38.57	47.11	38.57	0.10	1.00	0.42	0.69
Select	41.38	29.91	38.50	0.10	0.81	0.34	0.48
Yield Grade							
YG1,%	24.81	19.12	17.35	0.09	0.47	0.84	0.45
YG2,%	42.86	48.57	50.00	0.09	0.57	0.84	0.55
YG3,%	22.82	25.74	23.23	0.08	0.97	0.77	0.86
YG4-5,%	8.31	5.52	8.54	0.05	0.97	0.60	0.80

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.

[2]Contrast between Control and INTERM + ALL.

[3]Marbling score of 300= slight, 400=small, 500=modest, and 600=moderate.

Table 3.6. Effects of byproduct blend inclusion in finishing diet on fecal pH and score[1]

Item	Experimental Diet Treatment[2]				*P*-value		
	CONT	INTERM	ALL	SEM	Linear	Quadratic	CONT vs Byproduct[3]
pH							
day 0	6.91	6.94	6.93	0.02	0.45	0.26	0.23
day 14	6.03	6.07	6.44	0.08	0.0002	0.04	0.01
day 28	6.21	6.25	6.63	0.07	0.0002	0.02	0.004
day 56	6.14	6.33	6.68	0.07	0.0002	0.32	0.002
day 84	6.29	6.31	6.75	0.06	<0.0001	0.01	0.004
day 112	6.20	6.42	6.67	0.05	<0.0001	0.82	0.0001
day 142	6.26	6.43	6.72	0.06	0.0002	0.41	0.001
Score							
day 0	4.28	4.41	4.58	0.12	0.10	0.87	0.17
day 14	3.86	3.96	4.08	0.19	0.37	0.95	0.45
day 28	3.59	3.62	4.40	0.14	0.0008	0.03	0.02
day 56	3.25	3.74	3.84	0.15	0.01	0.28	0.01
day 84	3.48	3.96	4.18	0.18	0.01	0.54	0.02
day 112	3.54	3.58	4.07	0.14	0.01	0.17	0.08
day 142	3.34	3.70	3.73	0.12	0.03	0.28	0.02

[1]Fecal score adapted from Ireland-Perry and Stallings (1993); Larson et al. (1977), higher score indicating more viscous "watery" structure.

[2]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.

[3]Contrast between Control and INTERM + ALL.

Table 3.7 Effect of byproduct blend inclusion in finishing diet on fecal grab sample DM

Item	Experimental Diet Treatment[1], %DM				*P*-value		
	CONT	INTERM	ALL	SEM	Linear	Quadratic	CONT vs. Byproduct[2]
day 0	18.9	19.5	17.5	0.8	0.20	0.19	0.65
day 14	21.6	21.6	18.3	1.0	0.03	0.17	0.20
day 28	25.8	23.3	17.5	0.7	<0.0001	0.08	<0.0001
day 56	22.1	19.8	15.2	0.5	<0.001	0.10	<0.0001
day 84	21.5	20.3	16.8	0.9	0.004	0.30	0.02
day 112	21.8	19.7	13.5	0.4	<0.001	0.003	<0.0001
day 142	19.4	17.1	16.2	0.6	0.001	0.26	0.001

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.
[2]Contrast between Control and INTERM + ALL.

Table 3.8 Effect of byproduct blend inclusion in finishing diet on pad sample

Item	Experimental Diet Treatment[1]				*P*-value		
	CONT	INTERM	ALL	SEM	Linear	Quadratic	CONT vs. Byproduct[2]
Pad sample DM, %							
Day 56	47.71	47.66	34.89	2.82	0.001	0.02	0.02
Day 84	45.50	45.97	39.01	2.27	0.06	0.20	0.30
Day 112	56.55	52.48	46.77	1.80	0.001	0.65	0.003
Day 142	53.08	54.38	47.67	2.45	0.05	0.09	0.35
Density[3], As-is basis, kg/m^3							
Day 56	1011.03	924.78	1082.17	55.07	0.38	0.09	0.91
Day 84	1000.71	981.32	1057.08	51.16	0.42	0.43	0.75
Day 112	896.76	960.18	1013.04	47.75	0.06	0.91	0.08
Day 142	898.52	887.95	1067.65	67.67	0.01	0.08	0.13

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.
[2]Contrast between Control and INTERM + ALL.
[3]Density calculated by weighing a known volume (4.73 L) of pad sample.

Table 3.9 Effect of byproduct blend inclusion in finishing diet on pen depth

	Experimental Diet Treatment[1], cm				*P*-value		
Item	**CONT**	**INTERM**	**ALL**	**SEM**	**Linear**	**Quadratic**	**CONT vs. Byproduct[2]**
WK1	0.74	0.74	0.69	0.08	0.56	0.74	0.74
WK2	0.84	0.76	0.91	0.13	0.48	0.23	1.00
WK3	1.07	0.91	1.27	0.18	0.26	0.12	0.85
WK4	0.76	0.84	1.35	0.15	0.001	0.07	0.01
WK5	1.07	1.60	2.39	0.28	0.003	0.70	0.01
WK6	1.45	1.52	2.31	0.51	0.08	0.38	0.24
WK7	2.26	2.29	3.33	0.46	0.12	0.39	0.34

[1]Treatements of byproduct: control (CONT) 10% dried distillers grains, intermediate (INTERM) 22% Sweet Bran® 22% dried distillers grains plus solubles, 85% byproduct (ALL) 42% Sweet Bran® 42% dried distillers grains plus solubles.
[2]Contrast between Control vs. INTERM + ALL.

CHAPTER IV

TITRATING CORN-BASED DRIED DISTILLERS GRAINS TO SORGHUM-BASED WET DISTILLERS GRAINS ON FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF YEARLING BEEF HEIFERS

Abstract

This experiment compared performance and carcass effects when altering proportions of corn dry-distillers grains plus solubles (CDDG) to sorghum based wet-distillers grains plus solubles (SWDG) in a dry rolled corn finishing ration containing 30% distillers grains. Yearling cross-bred heifers (n = 150; initial BW 383 ± 28 kg) were blocked by BW, randomized to treatment, and fed for 125 d. Five ratios of byproducts were utilized in this experiment, 100 CDDG : 0 SWDG, 75 CDDG : 25 SWDG, 50 CDDG : 50 SWDG, 75 SWDG: 25 CDDG, and 0 CDDG : 100 SWDG. There were no differences ($P > 0.20$) among treatments in ADG, G:F, and DMI. A tendency ($P = 0.10$) for a linear increase in DMI, but a tendency ($P = 0.10$) for a linear decrease in ADG that resulted in a linear decrease in G:F. A tendency ($P = 0.06$) for a quadratic response in12th rib back fat with 100 : 0 having the greatest fat thickness followed by 0:100. No differences ($P > 0.16$) were detected for HCW, DP, marbling score, KPH or USDA YG.

This data suggest there are no differences in performance or carcass characteristics when switching ratios of DDG and SWDG when included at 30% in finishing diets.

Key words: distiller's grains, beef heifers, performance, carcass characteristics

Introduction

Production of distillers grains plus solubles have increased with increasing demand of ethanol over the last decade (RFA, 2012). The increased demand for grain from ethanol industries has increased the competition in purchasing corn for animal feeding, causing an increase in grain prices. Ethanol industries have been able to produce abundant supplies of wet distillers grains plus solubules (WDGS) and dry distillers grains plus solubles (DDGS). In the northern plains cattle feeding regions, WDGS are more typically fed due to being in close proximity of ethanol processing plants. In the southern plains cattle feeding areas, feeding DDGS would be more common due to distances from ethanol producing facilities to feedyards. Feeding byproducts such as DDGS, WDGS, and modified DGS (MDGS) can help lower cost of the beef production when cost of distillers grains is less than grain on DM basis. Buckner et al. (2008) evaluated DDGS in an economic analysis where DDGS were 80% and 100% the relative cost of corn. The findings concluded that feeding DDGS at 20% of the ration on DM basis was most cost efficient compared to corn or other levels of inclusion (Buckner et al., 2008). Ham et al. (1994) compared corn-based

WDGS to DDGS and concluded that cattle fed WDGS were more efficient than cattle fed DDGS, whereas WDGS had 24% higher feeding value than DDGS. In the southern plains, sorghum is commonly utilized in ethanol production. Sorghum contains similar starch levels compared to corn and produces similar ethanol yields (Klopfenstein et al., 2008). Sorghum is typically lower in price compared to corn, which makes it attractive to ethanol processing plants. Studies by Al-Suwaiegh et al. (2002); and; Lodge et al. (1997) indicated that sorghum WDGS had a numerically lower feeding value compared to corn, when fed in a DRC-based diet. Few studies have compared performance of sorghum-based WDGS (SWDG) to corn-based DDGS (CDDG) in DRC concentrate based diets. Depenbusch et al. (2009) reported no differences in DMI, G:F, and apparent total tract digestibility when comparing SWDGS to CDDGS at 15% of steam flaked corn based diet. Al-Suwaiegh et al. (2002) compared corn WDG to sorghum WDGS included at 30% of diet and reported similar results in DMI, ADG and G:F. However, no direct comparison was noted contrasting SWDG to CDDG. Therefore, the objectives of this experiment is to examine the effects of altering proportions of SWDG to CDDG in a dry rolled, corn-based finishing diet containing 30% distillers grains.

Materials and Methods

This experiment was conducted at the Willard Sparks Beef Research Center at Oklahoma State University through the Department of Animal Science. All animal use procedures were approved by the Oklahoma State University Institutional Animal Care and Use Committee.

Treatments

The current experiment was conducted as a completely randomized block design. Heifers were assigned to 3 blocks based on initial body weight. There were 2 replications per block. Treatments consisted of five different ratios of CDDG and SWDG included as 30% (DM basis) of a dry-rolled corn finishing diet. Combinations of byproducts included: 100 CDDG: 0 SWDG, 75 CDDG: 0 SWDG, 50 CDDG: 50 SWDG, 25 CDDG: 75 SWDG, 0 CDDG: 100 SWDG.

Cattle Management

Crossbred yearling heifers were received during a two week period in late June of 2011. Upon arrival, initial body weights were obtained and heifers were noted for hide color, horns, and any abnormalities (lameness, pinkeye, etc.). Heifers received vaccination against clostridial toxins, IBR, PI3, BRSV, BVD type I and II (Caliber 7 and Express 5; Boehringer Ingelheim, St. Joseph, MO), and external parasites (Ivomec Plus; Merial Animal Health, Duluth, GA). Heifers were later checked for pregnancy by a licensed veterinarian. Heifers that were greater than 120 d bred were not allocated to the experiment. Heifers that were less than 120 d bred received an injection 5 ml dinoprost tromethamine (Lutalyse, Pfizer Animal Health, New York City, NY). Heifers were weighed on d -1 (n = 150) to obtain BW for allocation to treatment pens. Heifers were blocked by BW and stratified across treatment pens by BW and hide color. Heifers were placed in 4.57 m x 15.24 m pens with a4.57 m fence-line feed bunk and a 4.57 m deep concrete apron extending into the pen. The feed bunk and apron were covered by a metal awning. On d 0, 150 hd of yearling crossbred heifers (initial BW 383 ± 28 kg) were weighed and implanted with 140 mg of trenbolone acetate and 14 mg of estradiol (Revalor H, Merck Animal Health, Lawrence, KS) and sorted into treatment pens.

Cattle were individually weighed across a certified scale before AM feeding every 28 d. For each weigh period, the individual animal scale was validated using representative quantities of 22.7 kg certified weights. A pencil shrink of 4% was applied to all body-weights. On d 98, 330 mg-hd^{-1}-d^{-1} of ractopamine hydrochloride (Optaflexx Elanco Animal Health, Indianapolis, IN) was included into each treatment ration and fed the final 27 d of the finishing period. Cattle were individually weighed at 0500 h on d 125 and shipped 521 km to Tyson Fresh Meats, Amarillo, TX for harvest. Harvest and carcass data was collected by trained personnel from the West Texas A&M University Beef Carcass Research Center.

Feed and Bunk Management

Bunks were read daily by trained personnel at 0600 and 1700 h, respectively, and feed calls were made to achieve a slick-bunk approach according to facility protocol. Heifers were fed twice daily at 0700 and 1000 h according to the program in table Table 4.2 using only the 100 CCD: 0 SWDG and 0 CDDG: 100 SWDG diets (Table 4.3) to create all treatment combinations. Heifers were adapted over a 22 d 2 ration blend method, using a common transitioning diet and treatment diet. Feed refusals were obtained on weigh days and during inclement weather conditions. Feed refusal subsamples (200 g) were taken and dried in a forced-air oven at 60°C for 48 h. Diets were mixed in a Kuhn-Knight 325 trailer type mixer.

Every morning manure, hair, etc. were removed from bunks before morning feeding. A 75.71 L concrete water tank (Model J 360-F, Johnson Concrete, Hastings, NE) was shared between two pens and was cleaned 3 times/wk throughout the 125 d experiment.

Experimental Design and Statistics

Performance data and carcass data were analyzed using the MIXED procedures of SAS 9.3 (SAS Inst. Inc., Cary NC). Means were evaluated for linear, quadratic, and CDDG vs. SWDG contrasts. Block was used as the random effect and pen was the experimental unit. Carcass weights from cattle that were noted as having a severe amount of carcass trim due to carcass contamination or abscessed livers and a dressing percentage below the pen average were adjusted back to the average dressing percentage for that pen. Carcass adjusted final BW, ADG, and G:F were calculated by using the average dressing percentage of all the cattle in the study (62.75%).

Results and Discussion

Nutrient composition of the treatment rations with 100 CCDG: 0 SWDG or 0 CCDG: 100 SWDG in trial is given in Table 4.2 and Table 4.3. The SWDG ration contained numerically more CP than the CDDGS ration when the rations were formulated to similar EE values. This agrees with the findings of Lodge et al. (1997)

on their nutrient analysis of byproducts. However, Lodge et al. (1997) stated that corn wet distillers grains contained more lipid versus sorghum DDGS, sorghum WDGS, and corn DDGS. The Beef NRC (NRC, 2000) states that sorghum grain contains 12.6% CP compared to corn at 9.8% CP, which agrees with the current analyses having numerically greater CP content in the SWDGS based diet. Sorghum WDGS contained 33.92% CP compared to CDDGS having 28.49%. Sorghum grain contains less ether extract compared to corn 3.03 vs. 4.06 respectively (NRC, 2000), however, analyses of current data showed that SWDGS contained 1.01 percentage units higher crude fat percentage compared to CDDGS.

Cattle Performance

No differences (Table 4.4) were observed between DMI ($P > 0.20$) or live weight or carcass adjusted final BW, ADG, G:F. Ham et al. (1994) evaluated feeding values of corn DDGS to corn WDGS. When included at 40% of dietary DM replacing corn, WDGS were more efficient than DDGS. This contrasts with the current study, whereas no differences were found for efficiency between SWDGS and CDDGS. Lodge et al. (1997) examined the feeding value of sorghum byproducts. When included at 40%, on DM basis, sorghum wet distillers grains, sorghum wet distillers grains plus solubles, and sorghum dry distillers grains plus solubles (SDDGS) contained 96, 102, and 80% relative NE_g of corn. In contrast, corn byproducts have been attributed to having 169% to 128% the energy value of corn (Larson et al., 1993) or 34% greater feeding value than corn (Klopfenstein et al., 2008). Furthermore, Klopfenstein et al. (2008) noted that DDGS had a lower feeding value than WDGS and that increasing inclusion of the byproducts above 25% in a diet resulted in a greater difference in feeding value favoring WDGS. In a finishing study by Al-Suwaiegh et al. (2002), feeding 30% corn wet distillers grains plus solubles (CWDG) and 30% SWDG resulted in similar ADG and efficiency of gain. However, DMI was greater for 30% SWDG when included in a dry-rolled corn based diet (Al-Suwaiegh et al., 2002), which agrees with the current study where the high SWDGS treatment had numerically highest DMI. In addition, calculated NEg was numerically greater for CWDG compared to SWDG (Al-Suwaiegh et al., 2002). In contrast Vasconcelos et al. (2007) reported a linear decrease in DMI with increasing levels of SWDG (0, 5, 10, and 15% of diet) in SFC based diets, but this was consistent with inclusion of CWDG in that research. Furthermore, no differences were noted in ADG and G:F comparing SWDG and CWDG in SFC based diets (Vasconcelos et al., 2007). In the current experiment, DMI differed numerically between treatments, whereas we expected to see a decrease in DMI with increasing SWDGS. Lodge et al. (1997) concluded that type of grain influences digestibility and subsequent energy values with CWDG having higher true nitrogen, apparent nitrogen, and organic matter digestibility than SWDG. Data suggest that feeding any combination of SWDGS and CDDGS results comparable performance for finishing cattle when included at 30% of diet in DRC-based diet.

Carcass

No differences (Table 4.6) were observed in HCW, DP, marbling score, KPH or USDA Yield Grade ($P < 0.16$). Similarly, Vasconcelos et al. (2007) reported no difference in HCW or DP when using SWDG at 5, 10, 15% replacing SFC in diets. In addition Lodge et al. (1997) found no differences in yield grade among treatment groups comparing SWDGS, sorghum dried distillers grains plus solubles (SDDGS), CCDGS, and CWDGS included at 40% of diet. There was a tendency (P = 0.09) for LMA to be smaller for 0 CCDG: 100 SWDG than 100 CDDG: 0 SWDG. In addition, a quadratic tendency (P = 0.06) in 12th rib-fat with 100 CDDG: 0 SWDG having the greatest fat depth followed by 0 CCDG: 100 SWDG, then 50 CCDG: 50 SWDG. Data from Vasconcelos et al. (2007) showed similar effects of inclusion of SWDG at 5, 10, and 15% in SFC diets with decreasing fat thickness. In contrast to the current data, Al-Suwaiegh et al. (2002) reported a tendency for SWDG to have a greater 12th rib fat than steers fed CWDG when included at 40% of diet. In addition, Vasconcelos et al. (2007) found that sorghum WDGS in SFC diets increased yield grade, which contrasts the current study. However, other research found no differences in 12th rib back fat (Ham et al., 1994; Koger et al., 2010; Lodge et al., 1997) when DGS were included up to 40% of diet. These results suggest feeding SWDG or CDDG has comparable effects on carcass merit.

Implications

Current data suggest that corn-based DDGS and sorghum-based WDGS can be used interchangeably on a DM basis with no effects on performance or carcass characteristics when included at 30% of diet in DRC based diets. This allows for inclusion of SWDGS and CDDGS to be based on non-nutritional factors such as, availability, storage and handling capabilities, cost, and mixing characteristics.

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Table 4.1 Feeding schedule of 30% corn DDGS or 30% sorghum-based WDGS diets

Treatment, DM Basis	0700 h call, % as-fed		1000 h call, % as-fed	
	100 CCDG: 0 SWDG	0 CCDG: 100 SWDG	100 CCDG: 0 SWDG	0 CCDG: 100 SWDG
100 CCDG: 0 SWDG	50	-	50	-
75 CCDG: 25 SWDG	75	-	-	25
50 CCDG: 50 SWDG	50	-	-	50
25 CCDG: 75 SWDG	-	75	25	-
0 CCDG: 100 SWDG	-	50	-	50

[1]SWDGS=Sorghum wet disitllers grains plus solubles, CDDGS=corn dried distillers grains plus solubles.

Table 4.2 Treatment diets and nutrient composition

Item	100 CCDG: 0 SWDG	0 CCDG: 100 SWDG
Dry-rolled corn	51.0	50.0
Sorghum wet distillers grains plus solubles	-	30.0
Corn dried distillers grains plus solubles	30.0	-
Prairie hay	9.0	9.0
Liquid supplement[1]	4.0	5.0
Dry supplement[2]	6.0	6.0
Analyzed nutrient content[3], DM basis		
Dry matter, %	81.00	63.00
Crude Protein,%	15.30 (1.35)	16.48 (0.46)
ADF,%	10.35 (0.63)	11.00 (0.35)
NDF,%	23.40 (1.74)	21.78 (0.62)
Crude Fat,%	4.93 (0.59)	5.10 (0.24)
Calcium,%	0.70 (0.12)	0.69 (0.15)
Phosphorus,%	0.46 (0.03)	0.51 (0.01)
Magnesium,%	0.20 (0.01)	0.23 (0.01)
Potassium,%	0.78 (0.05)	0.84 (0.03)
Sulfur,%	0.28 (0.03)	0.28 (0.01)
Sodium,%	0.14 (0.02)	0.16 (0.02)
Iron, mg/kg	114.67 (14.12)	154.83 (6.21)
Manganese, mg/kg	44.17 (6.90)	50.33 (5.57)
Copper, mg/kg	18.17 (2.42)	14.67 (2.25)
Zinc, mg/kg	100.33 (21.84)	98.17 (10.93)
TDN	88.23 (0.94)	87.97 (0.21)
NE_g, Mcal/kg	0.31 (<0.01)	0.31 (<0.01)
NE_m, Mcal/kg	0.45 (<0.01)	0.45 (<0.01)

[1]Synergy 19/14 (Westway Feed Products, New Orleans, LA).
[2]Formulated to contain 28.04% limestone, 1.64 % KCL, 0.88% MgO, 4.92% Salt, 3.28% urea, 39.69% ground corn, 20.49% wheat midds, 0.09% $CuSO_4$, 0.074% MnO, 0.014% Se, 0.33% $ZnSO_4$, 0.11% Vitamin A, 0.015% Vitamin E, 0.27% Rumensin-90, 0.167% Tylan 40.
[3]Samples were chemically analyzed by Servi-Tech Labs Inc., Dodge City, KS.

Table 4.3 Analyzed nutrient values of distillers grains plus solubles products fed, DM basis[1]

Item	**CDDG[2]**	**SWDG[3]**
Dry matter, %	90.34	41.02
Crude protein, % DM	28.49	33.92
ADF, % DM	15.40	20.64
NDF, % DM	41.88	32.79
Crude fat, % DM	10.59	11.60
Phosphorus, % DM	0.89	0.97
Magnesium, % DM	0.29	0.40
Potassium, % DM	1.00	1.14
Sulfur, % DM	0.60	0.67
NE_m, Mcal/kg	1.85	1.74
NE_g, Mcal/kg	1.21	1.12

[1] Samples were chemically analyzed by Servi-Tech Labs Inc., Dodge City, KS.
[2]CDG=Corn dried distillers grains plus solubles.
[3]SWDG= Sorghum wet distillers grains plus solubles.

Table 4.4 Effect of dietary inclusion of sorghum-based WDGS to corn DDGS when replacing DRC at 30% DM on feedlot performance

	Experimental Diet Treatment, CDDGS:SWDGS						*P-v*alue		
Item	**100:0**	**75:25**	**50:50**	**25:75**	**0:100**	**SEM**	**Linear**	**Quadratic**	**Dry vs. Wet**[2]
Pens	6	6	6	6	6	-	-	-	-
Initial hd Count	30	30	30	30	30	-	-	-	-
Final hd Count	29	30	29	30	29	-	-	-	-
Initial BW, kg	367	367	367	369	366	16	0.85	0.43	0.58
Final BW, kg	573	570	576	568	577	20	0.72	0.78	0.58
Carc. Adj Final BW, kg	575	572	572	569	573	21	0.73	0.66	0.83
Performance									
ADG, kg/d	1.64	1.63	1.67	1.60	1.68	0.05	0.69	0.64	0.49
DMI, kg/d	10.78	10.80	11.02	10.75	11.14	0.37	0.29	0.74	0.20
G:F	0.152	0.151	0.152	0.149	0.151	0.004	0.71	0.82	0.85
Carc. Adj. ADG, kg/d	1.66	1.64	1.64	1.61	1.66	0.05	0.75	0.53	0.92
Carc. Adj. G:F	0.155	0.152	0.149	0.150	0.149	0.004	0.31	0.60	0.36
COG[3], $/kg	1.94	2.02	2.11	2.14	2.20	0.06	0.002	0.68	0.004
NE_m, Mcal/kg[4]	1.91	1.90	1.89	1.90	1.89	0.03	0.63	0.88	0.62
NE_g, Mcal/kg[4]	1.26	1.26	1.25	1.25	1.25	0.03	0.63	0.89	0.62

[1]100:0= 100% corn DDGS, 75:25= 75% corn DDGS to 25% sorghum WDGS blend, 50:50= 50% corn DDGS to 50% sorghum WDGS blend, 25:75= 25% corn DDGS to 75% sorghum WDGS blend, 0:100= 100% sorghum WDGS when replacing dry rolled corn at 30% DM.

[2]Contrasts 100:0 vs 0:100 (30% corn DDGS) to (30% sorghum-WDGS) respectively

[3]COG = cost of gain [total ration cost (DM basis)/total weight gain (carcass adjusted final BW - initial BW)].

[4]NEm= Net energy maintenance, NEg= Net energy gain. Values calculated by using equations from Beef NRC., (2000).

Table 4.5 Effect of dietary inclusions of sorghum-based WDGS to corn DDGS when replacing DRC at 30% DM on performance, by period.

	Experimental Diet Treatment[1], CDDGS:SWDGS						*P*-value		
Item	**100:0**	**75:25**	**50:50**	**25:75**	**0:100**	**SEM**	**Linear**	**Quadratic**	**Dry vs. Wet[2]**
D 0-28									
ADG, kg/d	1.83	1.84	1.88	1.57	1.87	0.12	0.61	0.60	0.81
DMI, kg/d	10.11	9.92	9.82	9.95	9.82	0.54	0.51	0.71	0.43
G:F	0.181	0.188	0.194	0.159	0.191	0.016	0.81	0.80	0.50
D 29-56									
ADG, kg/d	1.36	1.52	1.47	1.61	1.51	0.10	0.20	0.35	0.26
DMI, kg/d	10.44	10.40	10.81	10.45	10.99	0.37	0.16	0.67	0.13
G:F	0.130	0.146	0.137	0.155	0.138	0.009	0.38	0.27	0.51
D 57-84									
ADG, kg/d	1.63	1.50	1.50	1.40	1.48	0.07	0.10	0.24	0.18
DMI, kg/d	10.82	11.28	11.56	11.21	11.58	0.33	0.10	0.42	0.05
G:F	0.151	0.134	0.130	0.125	0.129	0.007	0.02	0.12	0.03
D 85-125									
ADG, kg/d	1.71	1.64	1.77	1.74	1.80	0.10	0.26	0.79	0.42
DMI, kg/d	11.44	11.36	11.63	11.17	11.83	0.40	0.53	0.49	0.36
G:F	0.149	0.144	0.153	0.156	0.152	0.006	0.26	0.82	0.67

[1]100:0= 100% corn DDGS, 75:25= 75% corn DDGS to 25% sorghum WDGS blend, 50:50= 50% corn DDGS to 50% sorghum WDGS blend, 25:75= 25% corn DDGS to 75% sorghum WDGS blend, 0:100= 100% sorghum WDGS when replacing dry rolled corn at 30% DM.

[2]Contrasts 100:0 vs 0:100 (30% corn DDGS) to (30% sorghum-WDGS) respectively

Table 4.6 Effect of dietary inclusions of sorghum-based WDGS to corn DDGS when replacing DRC at 30% DM on carcass characteristics

	Experimental Diet Treatment[1], CDDGS:SWDGS						*P*-value		
Item	**100:0**	**75:25**	**50:50**	**25:75**	**0:100**	**SEM**	**Linear**	**Quadratic**	**Dry vs. Wet[2]**
HCW, kg	361	359	359	357	360	13	0.74	0.65	0.83
Dressing percentage	63.13	62.95	62.27	62.82	62.55	0.54	0.43	0.59	0.43
Marbling Score[3]	402	427	420	405	417	11.39	0.73	0.49	0.30
12th Rib-fat, cm.	1.65	1.47	1.52	1.40	1.57	0.08	0.26	0.06	0.39
Ribeye area, cm^2	92.90	87.10	92.90	92.26	86.45	3.10	0.38	0.57	0.09
KPH, %	2.43	2.34	2.41	2.38	2.43	0.04	0.90	0.32	1.00
USDA yield grade	3.02	3.11	2.91	2.74	3.25	0.17	0.86	0.16	0.32

[1]100:0= 100% corn DDGS, 75:25= 75% corn DDGS to 25% sorghum WDGS blend, 50:50= 50% corn DDGS to 50% sorghum WDGS blend, 25:75= 25% corn DDGS to 75% sorghum WDGS blend, 0:100= 100% sorghum WDGS when replacing dry rolled corn at 30% DM.
[2]Contrasts 100:0 vs. 0:100 (30% corn DDGS) to (30% sorghum-WDGS) respectively
[3]Marbling score of 300= slight, 400=small, 500=modest, and 600=moderate.

VITA

Blaine Thomas Johnson

Candidate for the Degree of

Master of Science/Arts

Thesis: EVALUATION OF BYPRODUCT COMBINATIONS ON FEEDLOT PERFORMANCE, CARCASS, AND FECAL CHARACTERISTICS

Major Field: Animal Science

Biographical:

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Name: Blaine Thomas Johnson Date of Degree: July, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: EVALUATION OF BYPRODUCT COMBINATIONS ON FEEDLOT PERFORMANCE, CARCASS, AND FECAL CHARACTERISTICS

Pages in Study: 84 Candidate for the Degree of Master of Science

Major Field: Animal Science

Scope and Method of Study:
The first experiment compared inclusion levels of a 1:1 blend of Sweet Bran® (SB) and dried distiller's grains (DDGS) byproducts in a dry-rolled corn feedlot ration on performance, carcass merit, and fecal characteristics. Heifers (n = 108; initial BW = 324 ± 13.6 kg) were blocked by BW, randomized to treatment, and fed for 142 d. Treatments were control (CONT, 8% DDGS), intermediate with 22% SB and 22% DDGS (INTER), and all byproduct with 44% SB and 44% DDGS (ALL). A second experiment compared performance and carcass effects of altering corn dried distillers grains plus solubles (DDGS) to sorghum-based wet distillers grains plus solubles (WDGS) ratios in a dry-rolled corn feedlot ration with 30% distillers grains plus solubles (DM basis). One hundred and eight yearling heifers (initial BW 383 ± 28 kg) were blocked by BW stratified by hide color and randomized to treatment, and finished for 125 d. Combinations of distillers grains evaluated were: 100% DDGS; 75% DDGS: 25% WDGS; 50% DDGS:50%WDGS; 25%DDGS:75%WDGS; and 100% WDGS.
Findings and Conclusions:
From experiment 1, dry matter intake resulted in a quadratic response (P = 0.05) and ADG and carcass adjusted ADG tended to result in quadratic responses (P >0.08) with INTERM being the highest. Final body weight was not different (P > 0.15) on a live basis, but was greater (P <0.03) for heifers fed the byproduct blend than the control. Gain to feed on a live and carcass adjusted basis increased linearly (P < 0.03) with increased byproduct inclusion. Dressing percentage increased linearly (P = 0.02) resulting in ALL having a 1.81% improvement in dressing percentage. There was a trend (P = 0.09) for a quadratic increase in HCW that was greater (P = 0.03) for heifers fed the byproduct blend than CONT, but no other differences (P > 0.19) in carcass characteristics. These data indicate that replacing dry-rolled corn in a finishing diet with a 1:1 blend of SB and DDGS increases feed efficiency and HCW without altering ADG calculated with live weights. Fecal pH and scores increased linearly (P < 0.03) at sampling points starting at d 28 with increasing byproduct blend. Fecal DM decreased linearly as byproduct inclusion increased (P < 0.03) at each sampling period. Pad sample DM decreased linearly ($P \leq 0.05$) on d 56, 112, and 142 and tended to decrease on d 84 (P = 0.06). Data indicates replacing corn with a 1:1 blend of SB and DDGS increases fecal pH, fecal score, and decreases fecal DM and DM of pen pad samples. In the second experiment, there were no differences (P > 0.20) among treatments in overall ADG, G:F, or DMI. No differences (P > 0.06) were detected in HCW, dressing percentage, marbling score, KPH or USDA Yield Grade. Data suggests that when fed at 30% of the finishing diet DM, corn DDGS and sorghum WDGS can be blended or exchanged with no impact on finishing performance or carcass characteristics.

ADVISER'S APPROVAL: Dr. Chris J. Richards